Department of the Interior Final

Shasta Lake Water Resources Investigation

Environmental Impact Statement

U.S. Department of the Interior — March 3, 1849

U.S. Department of the Interior — Bureau of Reclamation

December 2014

Mission Statements

Protecting America's Great Outdoors and Powering Our Future

The Department of the Interior protects and manages the Nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Final Environmental Impact Statement
Shasta Lake Water Resources Investigation

United States Department of the Interior
Bureau of Reclamation, Mid-Pacific Region
2800 Cottage Way, MP-700
Sacramento, CA 95825

This Final Environmental Impact Statement (EIS) for the Shasta Lake Water Resources Investigation (SLWRI) has been prepared by the U.S. Department of the Interior, Bureau of Reclamation (Reclamation), Mid-Pacific Region, consistent with requirements of the National Environmental Policy Act (NEPA). Cooperating agencies pursuant to NEPA include the U.S. Forest Service, Bureau of Indian Affairs, Colusa Indian Community Council of the Cachil Dehe Band of Wintun Indians, and U.S. Army Corps of Engineers.

The SLWRI is a feasibility study that is one of five studies for potential surface water storage projects included in the 2000 CALFED Bay-Delta Programmatic Record of Decision, and is being conducted under the general authority of Public Laws 96-375, which was reaffirmed under Public Law 108-361, also known as the CALFED Bay-Delta Authorization Act.

This EIS evaluates the potential environmental effects of alternative plans to enlarge Shasta Dam and Reservoir to (1) increase anadromous fish survival in the upper Sacramento River, primarily upstream from Red Bluff Pumping Plant, (2) increase water supplies and water supply reliability for agricultural, municipal and industrial, and environmental purposes, and (3) address related water resource problems, needs, and opportunities. In addition to the No-Action Alternative, this DEIS considers multiple action alternatives, which include potential dam raises ranging from 6.5 to 18.5 feet and related reservoir enlargements ranging from 256,000 to 634,000 acre feet.

In June 2013, Reclamation released the SLRWI Draft Environmental Impact Statement (DEIS) and appendices to the public. The public comment period closed September 2013. Over 600 comment letters were received on the DEIS. The Final EIS and related appendices include responses to public comments (Chapter 33, “Public Comments and Responses”) and related refinements to alternatives and impact evaluations and the identification of the preferred alternative.

For further information, please contact Katrina Chow, Project Manager, at the address above, by telephone at (916) 978-5067, or by e-mail at KChow@usbr.gov.

Shasta Lake Water Resources Investigation, California

Shasta Lake Water Resources Investigation, California Final Environmental Impact Statement

Prepared by:

United States Department of the Interior
Bureau of Reclamation
Mid-Pacific Region

December 2014

Executive Summary

S.1 Introduction and Background

This Environmental Impact Statement (EIS) has been prepared as part of the Shasta Lake Water Resources Investigation (SLWRI) to evaluate the potential physical, biological, cultural, and socioeconomic effects of implementing alternatives to modify the existing Shasta Dam and Reservoir, including taking no action. The SLWRI is a feasibility study being conducted by the U.S. Department of the Interior, Bureau of Reclamation (Reclamation), Mid-Pacific Region.

The SLWRI is being conducted consistent with the National Environmental Policy Act (NEPA), the 1983 U.S. Water Resources Council *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (P&G) (WRC 1983), and other pertinent Federal, State of California (State), and local laws and policies. Reclamation is serving as the Federal lead agency for compliance with NEPA. Cooperating agencies, pursuant to NEPA, include the U.S. Department of Agriculture, Forest Service (USFS); Colusa Indian Community Council of the Cachil Dehe Band of Wintun Indians; U.S. Army Corps of Engineers (USACE); and U.S. Department of the Interior (Interior), Bureau of Indian Affairs (BIA). This document has also been prepared in consideration of California Environmental Quality Act (CEQA) requirements.

Reclamation completed the *SLWRI Draft Feasibility Report* (Draft Feasibility Report), *SLWRI Preliminary Draft EIS* (Preliminary DEIS), and related appendices in November 2011. These documents were released to the public in February 2012 to present potential impacts, costs, and benefits of the action alternatives that had been evaluated at that time; to share information generated since the completion of the *SLWRI Plan Formulation Report* in December 2007; and to provide an additional opportunity for public and stakeholder input.

After the release of the Draft Feasibility Report and Preliminary DEIS, SLWRI alternatives were refined for the Draft EIS (DEIS) based on several factors, including updates to Central Valley Project (CVP) and State Water Project (SWP) water operations, and stakeholder input. Water operations modeling and related evaluations for the DEIS and this Final EIS reflect the following:

- The Reclamation 2008 *Biological Assessment on the Continued Long-Term Operations of the CVP and SWP* (2008 Long-Term Operation Biological Assessment (BA))

- The U.S. Department of Interior, Fish and Wildlife Service (USFWS) 2008 *Formal Endangered Species Act Consultation on the Proposed Coordinated Operations of the CVP and SWP* (2008 USFWS Biological Opinion (BO))

- The National Marine Fisheries Service (NMFS) 2009 *BO and Conference Opinion on the Long-Term Operations of the CVP and SWP* (2009 NMFS BO)

- Additional changes in CVP and SWP facilities and operations, such as implementation of the San Joaquin River Restoration Program

- Additional changes in non-CVP/SWP facilities and operations, such as the addition of the Freeport Regional Water Project

Reclamation released the DEIS for public review and comment in June 2013. In compliance with NEPA, a Notice of Availability (NOA) was published by Reclamation in the *Federal Register* (Federal Register Vol. 78, No. 126, 39315) on Monday, July 1, 2013, and an associated NOA was published by the U.S. Environmental Protection Agency (EPA) in the *Federal Register* (Federal Register Vol. 78, No. 129, 40474) on Friday, July 5, 2013.

Reclamation held three public workshops and three public hearings during the comment period on the DEIS. Each set of meetings were held in Redding, Sacramento, and Los Banos. Written and verbal comments were accepted at meetings and written comments were accepted throughout the comment period. The comment period on the DEIS began on July 1, 2013 and closed on September 30, 2013.

The public comments have been reviewed and, in accordance with NEPA Council on Environmental Quality (CEQ) Regulations, responses have been developed for all substantive comments and revision of the DEIS have been made to clarify and enhance the text to produce this SLWRI Final EIS. This Final EIS consists of revised chapters 1 through 31, a new Chapter 32, “Final EIS,” a new Chapter 33, “Public Comments and Responses,” and revised and new appendices.

During the process of addressing public comments on the DEIS, some notable content changes were made to this Final EIS, including:

- Refinement of the project purpose statement

- Clarification of the relationship of this EIS and tiering to the CALFED Bay-Delta Program (CALFED) Programmatic Environmental Impact Statement/Environmental Impact Report (PEIS/R)
- Refinement of the operational scenarios focused on anadromous fish survival, and the development, evaluation, and incorporation of Comprehensive Plan 4A (CP4A)
- Refinement of facility plans for recreation relocations, Shasta Dam modifications, Pit 7 Dam and Powerhouse modifications, and other reservoir area relocations (e.g., power transmission lines)
- Incorporation of updated resource information related to physical and biological resources in the primary study area
- Refinement of "maximum" affected areas and refinement of "most likely" affected areas for biological resources, based on facility and construction footprints
- Refinement and enhancement of the mitigation measures, including development of a framework to quantify impacts (where appropriate) and establish mitigation ratios that are applicable to a number of impacts related to biological resources, in conjunction with an interagency, interdisciplinary team

S.1.1 Background

Reclamation completed constructing Shasta Dam and Reservoir in 1945. Reclamation operates Shasta Dam and Reservoir, in conjunction with other facilities, to provide flood damage reduction and irrigation and municipal and industrial (M&I) water supply, maintain navigation flows, protect fish in the Sacramento River and the Sacramento-San Joaquin Delta (Delta), and generate hydropower. The Central Valley Project Improvement Act (CVPIA), enacted in 1992, added "fish and wildlife mitigation, protection, and restoration" as a priority equal to water supply, and "fish and wildlife enhancement" as a priority equal to hydropower generation. Major modifications to Shasta Dam include construction of a temperature control device (TCD) in 1997 for improved management of water temperatures in the upper Sacramento River.

Shasta Dam Under Construction

Shasta Dam and Reservoir were constructed as an integral element of the CVP, with Shasta Reservoir representing about 41 percent of the total reservoir storage capacity of the CVP. The 602-foot-tall Shasta Dam (533 feet above the streambed) and 4.55 million-acre-foot (MAF) Shasta Reservoir are located on the upper Sacramento River in Northern California, north of the City of Redding (see Figure S-1) within the Whiskeytown-Shasta-Trinity National Recreation Area (NRA). Shasta Lake supports extensive water-oriented recreation. Recreation within these lands is managed by USFS.

In 2000, as a result of the CALFED Programmatic Record of Decision (ROD), increasing demands for water supplies, and growing concerns over declines in ecosystem resources in the Central Valley of California, Reclamation reinitiated a feasibility investigation to evaluate the potential for enlarging Shasta Dam and Reservoir.

Figure S-1. Location of Shasta Dam and Reservoir

S.2 Study Authorization

The SLWRI is being conducted under the authority of Public Law 96-375, which was reaffirmed under Public Law 108-361, also known as the CALFED Bay-Delta Authorization Act. Public Law 96-375 (October 3, 1980) provides the authority for conducting a feasibility study for the SLWRI. It allows the Secretary of the Interior to:

> *…engage in feasibility studies relating to enlarging Shasta Dam and Reservoir, Central Valley Project, California or to the construction of a larger dam on the Sacramento River, California, to replace the present structure.*

Section 103(c), "Authorizations for Federal Activities Under Applicable Law," of the CALFED Bay-Delta Authorization Act (Public Law 108-361, October 25, 2004), authorizes the Secretary of the Interior to carry out the activities described in paragraphs (1) through (10) of Subsection (d), which include:

> *…(1)(A)(i) planning and feasibility studies for projects to be pursued with project-specific study for enlargement of (1) the Shasta Dam in Shasta County.*

Also, Section 103(a)(1) of Public Law 108-361 (October 25, 2004) states the following:

> *The Record of Decision is approved as a general framework for addressing the CALFED Bay-Delta Program, including its components relating to water storage, ecosystem restoration, water supply reliability (including new firm yield), conveyance, water use efficiency, water quality, water transfers, watersheds, the Environmental Water Account, levee stability, governance, and science.*

The CALFED Programmatic ROD called for the Secretary of the Interior to conduct feasibility studies for expanding CVP storage in Shasta Lake to:

> *…increase the pool of cold water available to maintain lower Sacramento River temperatures needed by certain fish and provide other water management benefits, such as water supply reliability.*

Other Federal legislation influences the SLWRI. Two laws of special note are Public Law 89-336 (November 8, 1965) and Public Law 102-575 (October 30, 1992). Public Law 89-336 created the Whiskeytown-Shasta-Trinity NRA, which includes Shasta Dam and Reservoir. Public Law 102-575, the CVPIA, directed numerous changes to CVP operations. Among these changes was adding "fish and wildlife protection, restoration, and enhancement" as a project purpose, which would result in substantial changes to water supply deliveries, river flows, and related environmental conditions in the primary and extended study areas.

S.3 Intended Use of Environmental Impact Statement

The purpose of an EIS is not to recommend approval or rejection of a project, but to provide information to aid the public and decision makers/permitting agencies in the decision-making process. An EIS identifies and evaluates alternatives that meet the project objectives, analyzes the potential environmental effects, and identifies measures to reduce or avoid potential environmental effects resulting from the action alternatives (i.e., mitigation measures). An EIS also must disclose adverse environmental impacts that cannot be avoided, cumulative impacts, the relationship of short-term uses and long-term productivity, and irreversible and irretrievable commitments of resources. In addition, NEPA requires that an EIS consider indirect effects of a project, which are often the result of growth inducement.

The SLWRI is one of five surface storage projects recommended for project-specific studies in the 2000 CALFED PEIS/R Preferred Program Alternative and associated CALFED Programmatic ROD. Consistent with guidance in the CALFED Programmatic ROD, this EIS relies on and tiers to the CALFED PEIS/R.

The SLWRI DEIS was released to the public in June 2013 and was circulated for review and comment by agencies, stakeholders, and the public to inform and engage interested persons in the planning and NEPA processes. Public outreach, including public workshops and hearings, was conducted during the 90-day DEIS public review period. Comments received during the public review period were considered and addressed and all comments and responses to comments are included in this Final EIS.

Reclamation posted the Final EIS at http://www.usbr.gov/mp/slwri for public review and issued a notice in the Federal Register and press release describing the public release of the Final EIS. It will be used by the Federal lead agency when considering approval of the proposed action or an alternative to the proposed action. All cooperating agencies and other Federal, State, and local agencies with permitting or approval authority over any aspect of the proposed action are expected to use the information contained in this Final EIS to meet most, if not all, of their information needs to make decisions and/or issue permits with respect to the proposed action.

S.4 Purpose and Need/Project Objectives

NEPA regulations require a statement of “the underlying purpose and need to which the agency is responding in proposing the alternatives, including the proposed action” (Title 40, Code of Federal Regulations (CFR) Part 1502.13). In California, the State CEQA Guidelines require a clearly written statement of objectives, including the underlying purpose of a proposed project (Title 14, California Code of Regulations Section 15124(b)).

S.4.1 Project Purpose and Objectives

Project Purpose

The purpose of the proposed action is to improve operational flexibility of the Sacramento-San Joaquin Delta (Delta) watershed system to meet specified primary and secondary project objectives.

Project Objectives

Two primary project objectives (also referred to as planning objectives) and five secondary project objectives were developed for the SLWRI:

Primary Project Objectives

- Increase the survival of anadromous fish populations in the Sacramento River, primarily upstream from Red Bluff Pumping Plant (RBPP)
- Increase water supply and water supply reliability for agricultural, M&I, and environmental purposes, to help meet current and future water demands, with a focus on enlarging Shasta Dam and Reservoir

Secondary Project Objectives

- Conserve, restore, and enhance ecosystem resources in the Shasta Lake area and along the upper Sacramento River
- Reduce flood damage along the Sacramento River
- Develop additional hydropower generation capabilities at Shasta Dam
- Maintain and increase recreation opportunities at Shasta Lake
- Maintain or improve water quality conditions in the Sacramento River downstream from Shasta Dam and in the Delta

Primary project objectives are those which specific alternatives are formulated to address. The two primary project objectives are considered to have coequal priority, with each pursued to the maximum practicable extent without adversely affecting the other. Secondary project objectives are considered to the extent possible through pursuit of the primary project objectives.

S.4.2 Project Need

The need for the proposed action is described below and summarized from the 2004 Reclamation *SLWRI Initial Alternatives Information Report*, the 2007 Reclamation *SLWRI Plan Formulation Report*, the 2011 *Draft Feasibility Report* (released in 2012), and the Plan Formulation Appendix.

Anadromous Fish Survival

The Sacramento River system supports four separate runs of Chinook salmon: fall-, late fall-, winter-, and spring-run. The adult populations of the four runs of salmon and other important fish species that spawn in the upper Sacramento

River have declined considerably over the last 40 years. Several fish species in the upper Sacramento River have been listed under the Federal Endangered Species Act: Sacramento River winter-run Chinook salmon (endangered), Central Valley spring-run Chinook salmon (threatened), Central Valley steelhead (threatened), and the Southern Distinct Population Segment of North American green sturgeon (threatened). Two of these species are also listed under the California Endangered Species Act: Sacramento River winter-run Chinook salmon (endangered) and Central Valley spring-run Chinook salmon (threatened).

Unsuitable water temperatures in the upper Sacramento River, especially in dry and critical years,[1] is a critical factor affecting the abundance of Chinook salmon and steelhead in the river. Water temperatures that are too high or, less commonly, too low, can be detrimental to the various life stages of Chinook salmon. Elevated water temperatures can negatively impact holding and spawning adults, egg viability and incubation, preemergent fry, and rearing juveniles and smolts, substantially diminishing the next generation of returning spawners. Stress caused by high water temperatures also may reduce the resistance of fish to parasites, disease, and pollutants. Releases of cold water from Shasta Reservoir can improve seasonal water temperatures in the Sacramento River downstream from Shasta Dam for anadromous fish during critical periods.

Various Federal, State, and local projects are addressing factors contributing to declines in anadromous fish populations. Recovery actions range from changing the timing and magnitude of reservoir releases to structural changes at Shasta Dam. Despite these steps, additional actions are needed to address anadromous fish survival in the upper Sacramento River.

Water Supply Reliability

Demands for water in California exceed available supplies. Reclamation's 2008 *Water Supply and Yield Study* describes dramatic increases in statewide population, land use changes, regulatory requirements, and limitations on storage and conveyance facilities that have resulted in unmet water demands and subsequent increases in competition for water supplies among urban, agricultural, and environmental uses. The California Department of Water Resources (DWR) *California Water Plan Update 2013* concludes that California is facing one of the most significant water crises in its history; drought impacts are growing, and climate change is affecting statewide hydrology. Challenges are greatest during dry years, when water supplies are less available. Despite significant physical improvements in water resource systems and in system management over the past few decades, California still faces unreliable water supplies, continued depletion and degradation of

[1] Throughout this document, water year types are defined according to the Sacramento Valley Index Water Year Hydrologic Classification unless specified otherwise.

groundwater resources, habitat and species declines, and unacceptable risks from flooding.

As the population of California grows, and the demand for adequate water supplies becomes more acute, the ability to maintain a healthy and viable industrial and agricultural economy while protecting aquatic species will be increasingly difficult. Compounding these issues, potential effects of climate change, such as changed precipitation patterns, less snowfall, and earlier snowmelt, may considerably increase the demands on available water supplies in the future. As owner and operator of the CVP, one of the largest water storage and conveyance systems in the world, Reclamation has identified the need to increase the reliability of CVP water deliveries to its water contractors, particularly during dry and critical water years. Similar needs and challenges are faced by the SWP and other water projects throughout the State. As one of many efforts to improve the reliability of California's water supply, the SLWRI was established to evaluate the potential to improve water supply reliability, primarily by modifying Shasta Dam and enlarging Shasta Lake.

Ecosystem Resources

The quantity, quality, diversity, and connectivity of riparian, wetland, floodplain, and shaded riverine habitat in along the Sacramento River have been severely limited through confinement of the river system by levees, reclamation of adjacent lands for farming, bank protection, construction of dams and reservoirs, channel stabilization, and land development, contributing to a decline in habitat and native species populations. Ecosystem restoration along the Sacramento River has been the focus of several ongoing programs, including the Senate Bill 1086 Program, CVPIA, CALFED, Central Valley Habitat Joint Venture, and numerous local programs within the Central Valley. Despite these efforts, a significant need remains to conserve and restore ecosystem resources along the Sacramento River.

Flood Management

Communities and agricultural lands in the Central Valley are subject to flooding along the Sacramento River that poses risks to human life, health, safety, and property. Physical impacts from flooding include damage to buildings, contents, automobiles, agricultural crops, equipment, etc. Threats from flooding are caused by many factors, including overtopping or sudden failures of levees, which can result in deep and rapid flooding with little warning. In addition, urban development in flood-prone areas has exposed the public to the risk of flooding.

Hydropower

Although California is the most energy-efficient state per capita in the nation, demands for electricity are growing at a rapid pace. According to the California Energy Commission's *2012 Integrated Energy Policy Report Update*, over the next 10 years, California's peak demand for electricity is expected to increase at a rate of approximately 1.5 percent per year through 2022, from about 60,000 megawatts (MW) in 2011 to about 70,000 MW by 2022. Executive Orders S-14-08 and S-21-09, issued in 2008 and 2009, respectively, established a goal of using renewable energy sources, including hydropower, for 33 percent of the State’s energy consumption by 2020. To implement recent California renewable resources mandates, significant increases in non-dispatchable intermittent renewable resources, such as wind and solar generation, will need to be added to California’s power system. This means that other significant flexible generation resources, such as hydropower, will be needed to support and integrate renewable generation. Adding to the need for additional energy sources, existing nuclear power plants are nearing the end of their design lives and some may be offline within the next 10 to 20 years.

Recreation

As California’s population continues to grow, demands will increase substantially for recreation opportunities at and near the lakes, reservoirs, streams, and rivers of the Central Valley. Further increases in demand, accompanied by relatively static recreation resources, will cause issues at existing recreation areas. These challenges will be especially pronounced at Shasta Lake, which is one of the most visited recreation destinations in the State and in the region. Even under current levels of demand, USFS, which manages recreation at Shasta Lake, has expressed concern about seasonal access and capacity problems at existing marinas and USFS facilities. A substantial and increasing need exists to improve recreation-related facilities and conditions at Shasta Lake.

Water Quality

The Sacramento River and the Delta support fish and wildlife while providing water supplies for urban, agricultural, and environmental uses across the State. Saltwater intrusion, municipal discharges, agricultural drainage, and water project flows and diversions have led to water quality issues within the Delta, particularly related to salinity. In the Sacramento River, urban and agricultural runoff, and runoff and seepage from abandoned mining operations, have resulted in elevated levels of pesticides, phosphorous, mercury, and other metals. Additional operational flexibility could provide opportunities to improve Sacramento River and Delta water quality conditions.

S.5 Study Area


Present Shasta Dam

Shasta Dam and Shasta Lake are located on the upper Sacramento River in Northern California, approximately 9 miles northwest of Redding in Shasta County. Because of the potential influence of the proposed modification of Shasta Dam and subsequent system operations and water deliveries on resources over a large geographic area, the SLWRI includes both a primary study area and an extended study area. As shown in Figure S-2, the primary study area includes Shasta Dam and Lake; the lower portions of all contributing major and minor tributaries flowing into Shasta Lake; Trinity and Lewiston reservoirs; and the Sacramento River between Shasta Dam and the RBPP, including tributaries at their confluence. The extended study area includes the Sacramento River downstream from the RBPP, including portions of the American and Feather river basins downstream from CVP/SWP reservoirs and related facilities; the San Francisco Bay/Sacramento-San Joaquin Delta (Bay-Delta); lower portions of the San Joaquin River basin downstream from CVP reservoirs and related facilities (Friant and New Melones reservoirs); and CVP and SWP facilities and water service areas (shown in Figure S-3).

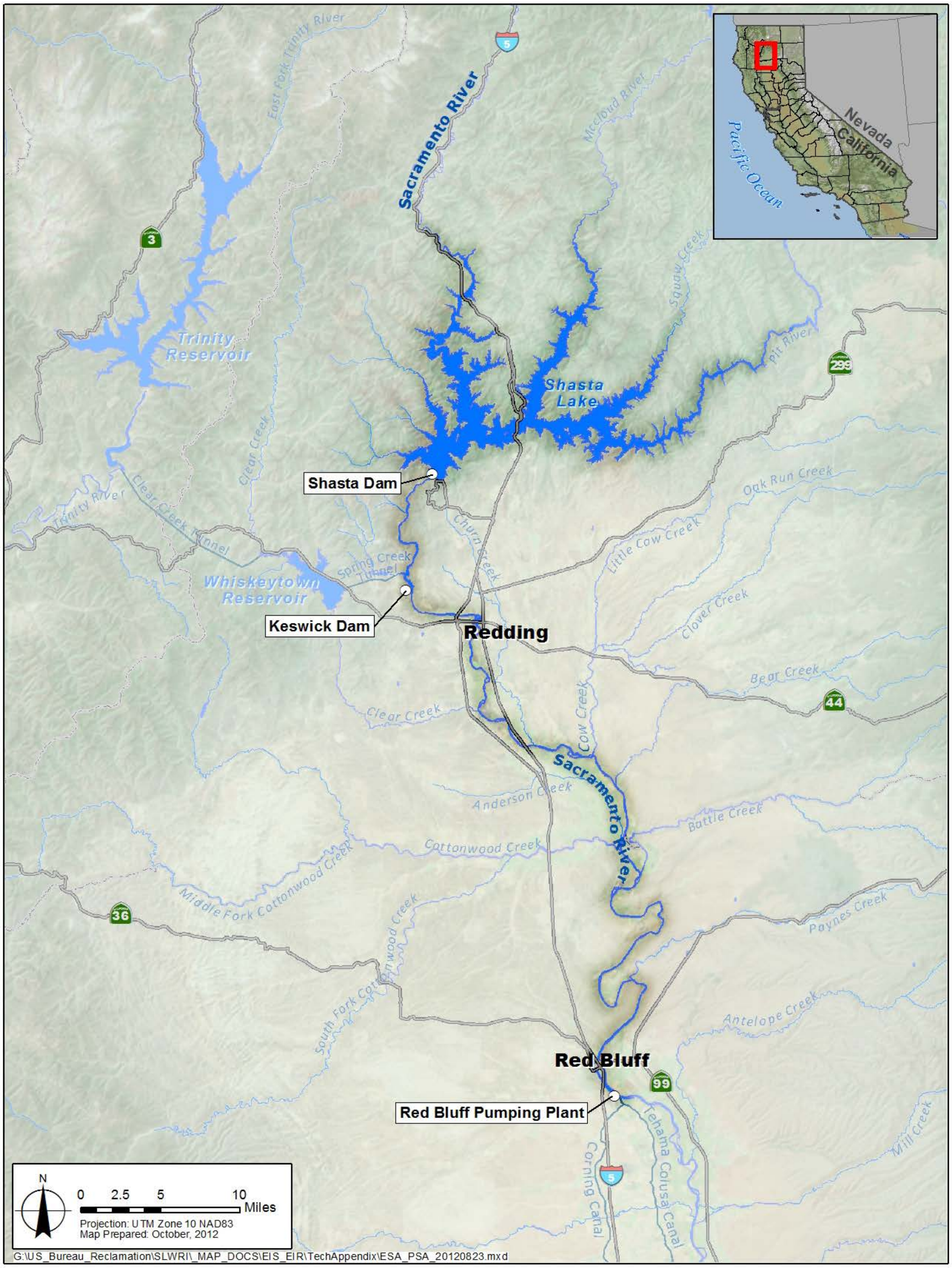


Figure S-2. Primary Study Area – Shasta Lake Area and Sacramento River from Shasta Dam to Red Bluff Pumping Plant

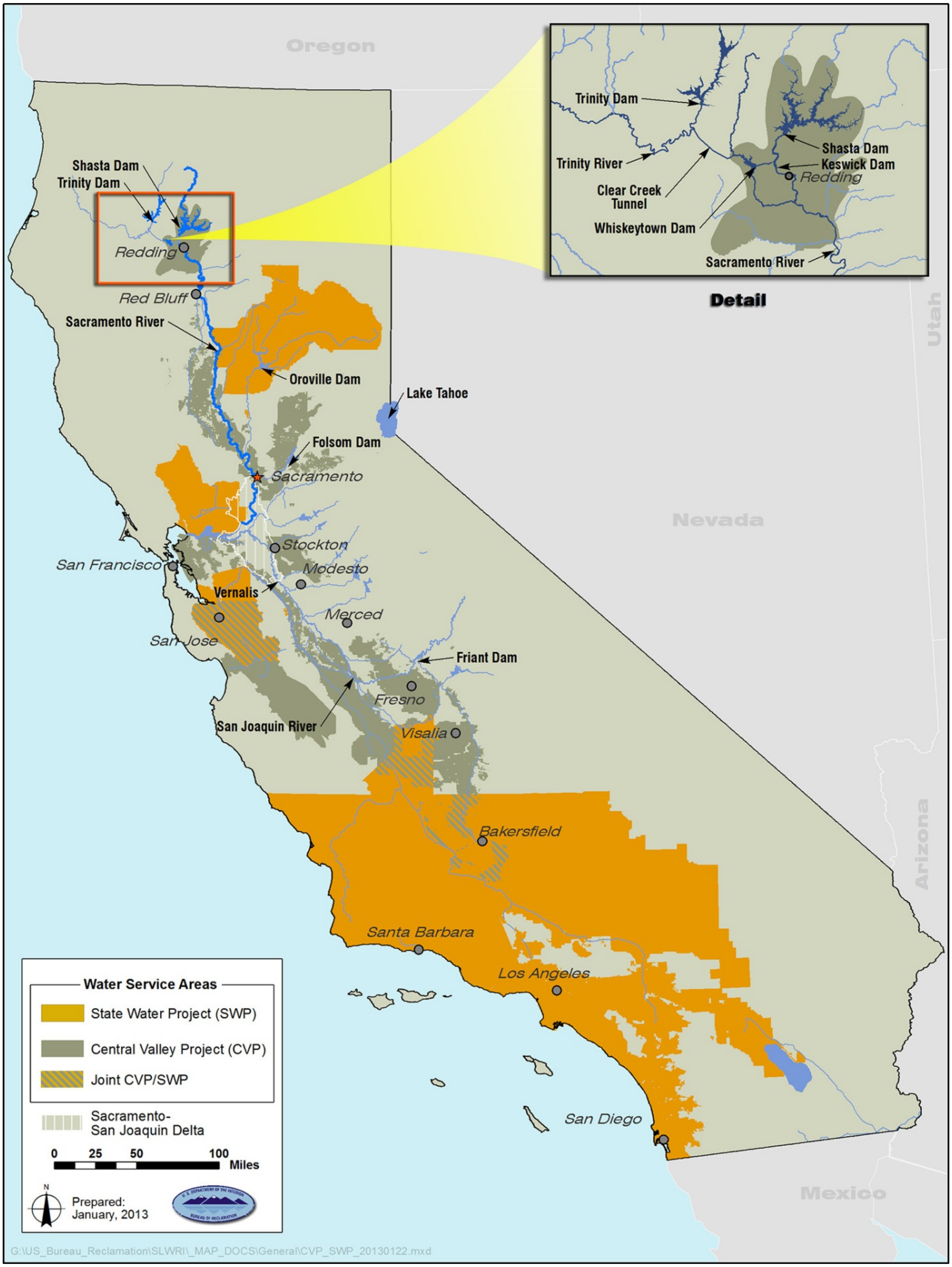


Figure S-3. Central Valley Project and State Water Project Facilities and Water Service Areas

S.6 Summary Description of Alternatives

Consistent with NEPA and the P&G, the plan formulation process for the SLWRI was divided into multiple phases, as shown in Figure S-4. Through this process, comprehensive plans (i.e., action alternatives) were formulated in addition to a No-Action Alternative. Each of the comprehensive plans includes enlarging Shasta Dam and Reservoir and a variety of management measures to address, in varying degrees, all of the project objectives. All of the comprehensive plans include eight common management measures:

- **Enlarge Shasta Lake cold-water pool –** All action alternatives would involve enlarging the cold-water pool by raising Shasta Dam to enlarge Shasta Reservoir.

- **Modify temperature control device –** Minimum modifications to the TCD under all action alternatives would include raising the existing structure and modifying the shutter control.

- **Increase conservation storage –** All action alternatives would increase the conservation storage in Shasta Reservoir by raising Shasta Dam.

- **Reduce demand –** All action alternatives would include a water conservation program for increased water deliveries that would be created by the project to augment current water use efficiency practices.

- **Modify flood operations –** Enlarging Shasta Reservoir would require adjustment of the existing flood operation guidelines, or rule curves, to reflect physical modifications, such as an increase in dam/spillway elevation; the rule curves would be revised with the goal of reducing flood damage and enhancing other objectives to the extent possible.

- **Modify hydropower facilities –** Enlarging Shasta Dam would require various modifications to the dam's existing hydropower facilities to enable their continued efficient use.

- **Maintain and increase recreation opportunities –** Recreation is important to the Shasta Lake region; therefore, existing recreation opportunities would be maintained and/or increased under all action alternatives.

- **Maintain or improve water quality –** All action alternatives would maintain and potentially improve water quality by increasing Delta outflow during drought years and reducing salinity during critical periods, and may also provide additional operational flexibility for responses to Delta emergencies.

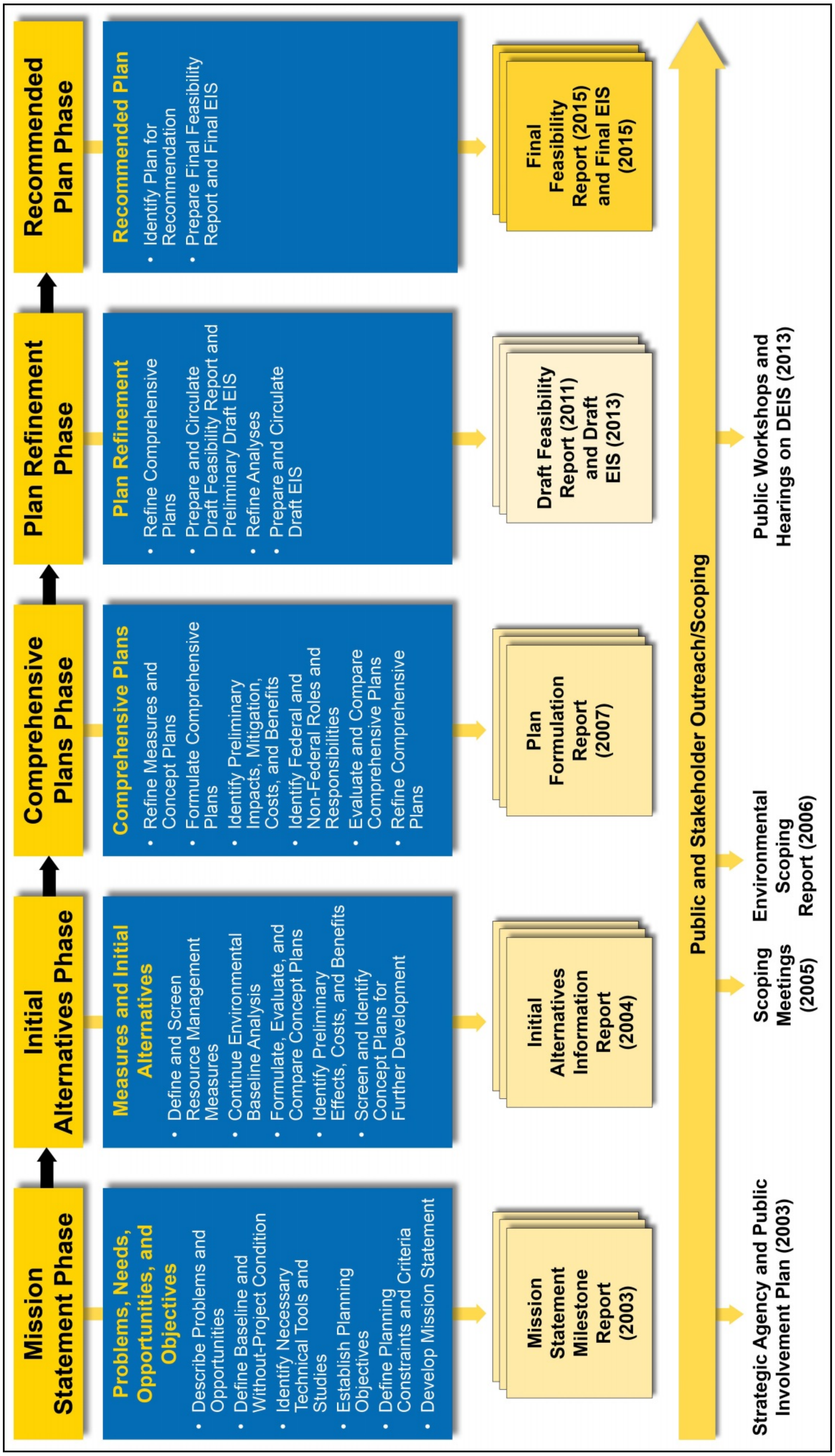


Figure S-4. Plan Formulation Phases

In addition, Reclamation has incorporated environmental commitments into each of the comprehensive plans to avoid or minimize potential impacts. Each comprehensive plan also includes mitigation measures where feasible to avoid, minimize, rectify, reduce, or compensate for significant and potentially significant impacts.

The No-Action Alternative and the comprehensive plans are summarized below.

S.6.1 No-Action Alternative

For the SLWRI, under the No-Action Alternative, the Federal Government would continue to implement reasonably foreseeable actions, including actions with current authorization, secured funding for design and construction, and environmental permitting and compliance activities that are substantially complete. However, the Federal Government would not take additional actions toward implementing a plan to raise Shasta Dam to help increase anadromous fish survival in the upper Sacramento River, nor help address the growing water supply and reliability issues in California. The following discussions highlight the consequences of implementing the No-Action Alternative, as they relate to project objectives.

Anadromous Fish Survival

Much has been done to address anadromous fish survival problems in the upper Sacramento River. Solutions have ranged from changes in the timing and magnitude of releases from Shasta Dam to constructing and operating the TCD at the dam. Actions also include site-specific projects, such as introducing spawning gravel to the Sacramento River, and work to improve or restore spawning habitat in tributary streams. However, to increase anadromous fish survival and reduce the risk of extinction, further water temperatures improvements are needed in the Sacramento River, especially in dry and critical years. According to the NMFS 2014 *Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-run Chinook Salmon and Central Valley Spring-run Chinook Salmon and the Distinct Population Segment of Central Valley Steelhead*, prolonged drought that depletes the cold-water pool in Shasta Reservoir could place populations of anadromous fish at risk of severe population decline or extirpation in the long-term. Under the No-Action Alternative, it is assumed that actions to protect fisheries and benefit aquatic environments would continue, including maintaining the TCD, ongoing spawning gravel augmentation programs, and satisfying other existing regulatory requirements.

Water Supply Reliability

Demands for water in California will continue to exceed available supplies, and the need for additional supplies is expected to grow. Competition for available water supplies would intensify as water demands increase to support population growth. Water conservation and reuse efforts are expected to substantially increase, and forced conservation as the result of increasing water shortages would continue. It is likely that with continued and deepening shortages in available water supplies, adverse economic and socioeconomic impacts would increase over time in the Central Valley and elsewhere in California.

Ecosystem Resources, Flood Management, Hydropower, Recreation, and Water Quality

Under the No-Action Alternative, the Federal Government would continue to implement reasonably foreseeable actions, but would not take additional actions to help restore ecosystem resources, develop additional hydropower generation, reduce flood damage, increase recreation opportunities at Shasta Lake, or improve water quality in the Sacramento River and the Delta. This would result in the following conditions:

- As opportunities arise, some efforts would likely continue to improve environmental conditions on tributaries to Shasta Lake and along the upper Sacramento River. However, overall, future environmental-related conditions in these areas would likely be similar to existing conditions.

- The threat of flooding would continue, and may increase as population growth continues.

- California's demand for electricity is expected to increase substantially in the future. No actions would be taken to help meet this growing demand.

- As California's population continues to grow, demands would grow substantially for water-oriented recreation at and near the lakes, reservoirs, streams, and rivers of the Central Valley. This increase in demand would be especially pronounced at Shasta Lake.

- To address the impact of water quality deterioration on the Sacramento River basin and Delta ecosystems, several environmental flow goals have been established through legal mandates. Despite these efforts, these resources would continue to decline and ecosystems would continue to be impacted.

S.6.2 Comprehensive Plan 1 (CP1) – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

CP1	
Dam Raise	*6.5 feet*
Increased Storage	*256,000 acre-feet*
Focus	*Anadromous Fish Survival & Water Supply Reliability*
Major Components	*Dam Modifications & Reservoir Area Relocations*
	Environmental Commitments & Mitigation Measures

CP1 focuses on both anadromous fish survival and water supply reliability. This alternative primarily consists of enlarging Shasta Dam by raising the crest 6.5 feet and implementing the set of eight common management measures described above. CP1 also includes implementing environmental commitments and mitigation measures. By raising Shasta Dam from a crest at elevation 1,077.5 feet above mean sea level (elevation 1,077.5) to elevation 1,084.0 (based on the National Geodetic Vertical Datum 1929 (NGVD29)),[2] in combination with spillway modifications, this alternative would increase the height of the reservoir's full pool by 8.5 feet. This increase in full pool height would add approximately 256,000 acre-feet of additional storage to the overall reservoir capacity. Accordingly, the overall full pool storage would increase from 4.55 MAF to 4.81 MAF.

Under CP1, the additional storage in Shasta Reservoir would be used to increase water supply reliability and to expand the cold-water pool for downstream anadromous fisheries. Enlarging Shasta Reservoir would increase the depth and volume of the cold-water pool, increasing the ability of Reclamation to release cold water from Shasta Dam and regulate seasonal water temperatures for fish in the upper Sacramento River during critical periods. This alternative (and all action alternatives) includes extending the existing TCD for efficient use of the expanded cold-water pool. CP1 would increase water supply reliability for agricultural, M&I, and environmental purposes. CP1 would also help reduce future water shortages through increasing irrigation and M&I deliveries, primarily during drought periods.

CP1 also addresses secondary planning objectives related to hydropower generation, recreation, flood damage reduction, ecosystem restoration, and water quality. Higher water surface elevations in the reservoir would result in an increase in power generation. CP1 includes features to at least maintain the existing recreation capacity at Shasta Lake, and water-oriented recreation experiences would be enhanced due to an increase in average lake surface area, reduced drawdown during the recreation season, and modernization of recreation facilities. Enlarging Shasta Dam would provide for incidental

[2] Dam crest elevations are based on NGVD29. All current feasibility-level designs and figures for Shasta Dam and appurtenant structures are based on NGVD29.

increased reservoir capacity to capture flood flows, which could reduce flood damage along the upper Sacramento River. Improved fisheries conditions as a result of CP1, and increased flexibility to meet flow and temperature requirements, could also enhance overall ecosystem resources in the Sacramento River. Additional storage in Shasta Reservoir would also provide improved operational flexibility for meeting Delta water quality objectives through increased and/or high-flow releases to improve Delta water quality.

Operations for water supply, hydropower, and environmental and other regulatory requirements would be similar to existing operations, except during dry and critical years when a portion of the increased storage in Shasta Reservoir would be reserved to specifically focus on increasing M&I deliveries. In dry years, 70,000 acre-feet of the 256,000 acre-feet increased storage capacity in Shasta Reservoir would be reserved for increasing M&I deliveries. In critical years, 35,000 acre-feet of the increased storage capacity would be reserved for increasing M&I deliveries.

S.6.3 Comprehensive Plan 2 (CP2) – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

CP2	
Dam Raise	*12.5 feet*
Increased Storage	*443,000 acre-feet*
Focus	*Anadromous Fish Survival & Water Supply Reliability*
Major Components	*Dam Modifications & Reservoir Area Relocations*
	Environmental Commitments & Mitigation Measures

CP2 focuses on both anadromous fish survival and water supply reliability. This alternative primarily consists of enlarging Shasta Dam by raising the crest 12.5 feet and implementing the set of eight common management measures described above. CP2 also includes implementing environmental commitments and mitigation measures. A dam raise of 12.5 feet was chosen because it represents a midpoint between the likely smallest dam raise considered and the largest practical dam raise that would not require relocating the Pit River Bridge. By raising Shasta Dam from a crest at elevation 1,077.5 to elevation 1,090.0 (NGVD29), in combination with spillway modifications, CP2 would increase the height of the reservoir's full pool by 14.5 feet. This increase in full pool height would add approximately 443,000 acre-feet of storage to the reservoir's capacity. Accordingly, storage in the overall full pool would increase from 4.55 MAF to 5.0 MAF.

Under CP2, the additional storage in Shasta Reservoir would be used to increase water supply reliability and to expand the cold-water pool for downstream anadromous fisheries. CP2 would increase the ability of Shasta Dam to regulate seasonal water temperatures for fish, primarily during critical periods, and would increase water supply reliability for agricultural, M&I, and environmental purposes. CP2 would also help reduce future water shortages through increasing irrigation and M&I deliveries, primarily during drought periods.

CP2 also addresses secondary planning objectives related to hydropower generation, recreation, flood damage reduction, ecosystem restoration, and water quality. Higher water surface elevations in the reservoir would result in an increase in power generation. CP2 includes features to at least maintain the existing recreation capacity at Shasta Lake, and water-oriented recreation experiences would be enhanced due to an increase in average lake surface area, reduced drawdown during the recreation season, and modernization of recreation facilities. Enlarging Shasta Dam would provide for incidental increased reservoir capacity to capture flood flows, which could reduce flood damage along the upper Sacramento River. Improved fisheries conditions as a result of CP2, and increased flexibility to meet flow and temperature requirements, could also enhance overall ecosystem resources in the Sacramento River. Additional storage in Shasta Reservoir would also provide improved operational flexibility for meeting Delta water quality objectives through increased and/or high-flow releases to improve Delta water quality.

Operations for water supply, hydropower, and environmental and other regulatory requirements would be similar to existing operations, except during dry and critical years when a portion of the increased storage in Shasta Reservoir would be reserved to specifically focus on increasing M&I deliveries. In dry years, 120,000 acre-feet of the 443,000 acre-feet increased storage capacity in Shasta Reservoir would be reserved for increasing M&I deliveries. In critical years, 60,000 acre-feet of the increased storage capacity would be reserved for increasing M&I deliveries.

S.6.4 Comprehensive Plan (CP3) – 18.5-Foot Dam Raise, Agricultural Water Supply Reliability and Anadromous Fish Survival

CP3	
Dam Raise	*18.5 feet*
Increased Storage	*634,000 acre-feet*
Focus	*Agricultural Water Supply Reliability & Anadromous Fish Survival*
Major Components	*Dam Modifications & Reservoir Area Relocations*
	Environmental Commitments & Mitigation Measures

CP3 focuses on both agricultural water supply reliability and anadromous fish survival. This alternative primarily consists of enlarging Shasta Dam and Reservoir by raising the dam crest 18.5 feet and implementing the set of eight common management measures described above. CP3 also includes implementing environmental commitments and mitigation measures.

By raising Shasta Dam from a crest at elevation 1,077.5 to elevation 1,096.0 (NGVD29), in combination with spillway modifications, CP3 would increase the height of the reservoir's full pool by 20.5 feet. This increase in full pool height would add approximately 634,000 acre-feet of storage to the reservoir's capacity. Accordingly, storage in the overall full pool would be increased from 4.55 MAF to 5.19 MAF. Although higher dam raises are technically and physically feasible, 18.5 feet is the largest dam raise that would not require extensive and costly reservoir area relocations, such as relocating the Pit River Bridge, Interstate 5, and the Union Pacific Railroad tunnels.

Because CP3 focuses on increasing agricultural water supply reliability and anadromous fish survival, none of the increased storage capacity in Shasta Reservoir would be reserved for increasing M&I deliveries. Operations for water supply, hydropower, and environmental and other regulatory requirements would be similar to existing operations. The additional storage would be retained for water supply reliability and to expand the cold-water pool for downstream anadromous fisheries. CP3 would increase the ability of Shasta Dam to regulate seasonal water temperatures for fish, primarily during critical periods, and would increase water supply reliability for agricultural, M&I, and environmental purposes. CP3 would also help reduce future water shortages through increasing irrigation deliveries.

CP3 also addresses secondary planning objectives related to hydropower generation, recreation, flood damage reduction, ecosystem restoration, and water quality. Higher water surface elevations in the reservoir would result in an increase in power generation. CP3 includes features to at least maintain the existing recreation capacity at Shasta Lake, and water-oriented recreation experiences would be enhanced due to an increase in average lake surface area, reduced drawdown during the recreation season, and modernization of recreation facilities. Enlarging Shasta Dam would provide for incidental increased reservoir capacity to capture flood flows, which could reduce flood damage along the upper Sacramento River. Improved fisheries conditions as a result of CP3, and increased flexibility to meet flow and temperature requirements, could also enhance overall ecosystem resources in the Sacramento River. Additional storage in Shasta Reservoir would also provide improved operational flexibility for meeting Delta water quality objectives through increased and/or high-flow releases to improve Delta water quality.

S.6.5 Comprehensive Plan 4 (CP4) and Comprehensive Plan 4A (CP4A) – 18.5-Foot Dam Raise, Anadromous Fish Focus with Water Supply Reliability

CP4 and CP4A	
Dam Raise	*18.5 feet*
Increased Storage	*634,000 acre-feet*
Focus	*Anadromous Fish Survival with Water Supply Reliability*
Major Components	*Dam Modifications & Reservoir Area Relocations*
	Adaptive Management *CP4 –Reserving 378,000 acre-feet of Storage for Cold-Water Pool* *CP4A – Reserving 191,000 acre-feet of Storage for Cold-Water Pool*
	Augment Spawning Gravel
	Restore Riparian, Floodplain, & Side Channel Habitat
	Environmental Commitments & Mitigation Measures

CP4 and CP4A focus on increasing anadromous fish survival, while also increasing water supply reliability. CP4 and CP4A are identical except for Shasta Dam and reservoir operations. CP4 and CP4A have similar reservoir operations in that they each dedicate a portion of the new storage in Shasta Lake for fisheries purposes; however, the portion of this dedicated storage varies.

These alternatives primarily consist of enlarging Shasta Dam and Reservoir by raising the dam crest 18.5 feet and implementing the set of eight common management measures described above. CP4 and CP4A also include implementing environmental commitments and mitigations measures. In addition, CP4 and CP4A would dedicate a portion of the increased storage in Shasta Reservoir for maintaining cold-water volumes to benefit anadromous fish in the upper Sacramento River. CP4 and CP4A also include two additional ecosystem restoration features: (1) augmenting spawning gravel in the upper Sacramento River at targeted locations to provide either immediate spawning habitat or long-term recruitment, and (2) restoring riparian, floodplain, and side channel habitat in the upper Sacramento River to provide rearing habitat for juvenile salmonids.

The additional storage created by the 18.5-foot dam raise would be used to improve the ability to meet water temperature objectives and habitat requirements for anadromous fish during drought years and increase water supply reliability. By raising Shasta Dam from a crest at elevation 1,077.5 to elevation 1,096.0 (NGVD29), in combination with spillway modifications, CP4 and CP4A would increase the overall full pool storage from 4.55 MAF to 5.19 MAF. Of the increased reservoir storage space, about 378,000 acre-feet would be dedicated to increasing the supply of cold water for anadromous fish survival purposes in CP4; 191,000 acre-feet would be dedicated in CP4A. Operations of the cold-water pool would be subject to an adaptive management plan that may include operational changes to the timing and magnitude of release from Shasta Dam to benefit anadromous fish. For CP4, operations for the remaining portion of increased storage (approximately 256,000 acre-feet) would be the same as for CP1, with 70,000 acre-feet reserved in dry years and 35,000 acre-feet reserved in critical years to specifically focus on increasing M&I deliveries. For CP4A, operations for the remaining portion of increased storage (approximately 443,000 acre-feet) would be the same as in CP2, with 120,000 acre-feet reserved in dry years and 60,000 acre-feet reserved in critical years to specifically focus on increasing M&I deliveries.

CP4 and CP4A also address secondary planning objectives related to hydropower generation, recreation, flood damage reduction, ecosystem restoration, and water quality. Higher water surface elevations in the reservoir would result in an increase in power generation. CP4 and CP4A include features to at least maintain the existing recreation capacity at Shasta Lake, and water-oriented recreation experiences would be enhanced due to an increase in average lake surface area, reduced drawdown during the recreation season, and modernization of recreation facilities. Enlarging Shasta Dam would provide for incidental increased reservoir capacity to capture flood flows, which could reduce flood damage along the upper Sacramento River. Improved fisheries conditions as a result of CP4 and CP4A, and increased flexibility to meet flow and temperature requirements, could also enhance overall ecosystem resources in the Sacramento River. Additional storage in Shasta Reservoir would also provide improved operational flexibility for meeting Delta water quality objectives through increased and/or high-flow releases to improve Delta water quality.

S.6.6 Comprehensive Plan 5 (CP5) – 18.5-Foot Dam Raise, Combination Plan

CP5	
Dam Raise	*18.5 feet*
Increased Storage	*634,000 acre-feet*
Focus	*Water Supply Reliability, Anadromous Fish Survival, Ecosystem Restoration, and Recreation*
Major Components	*Dam Modifications & Reservoir Area Relocations*
	Construct Resident Fish Habitat at Shasta Lake & along Tributaries
	Augment Spawning Gravel
	Restore Riparian, Floodplain, & Side Channel Habitat
	Increase Recreation Opportunities
	Environmental Commitments & Mitigation Measures

CP5 focuses on anadromous fish survival, increased water supply reliability, ecosystem enhancements in the Shasta Lake area and the upper Sacramento River upstream from the RBPP, and increased recreation opportunities around Shasta Lake. This alternative primarily consists of raising Shasta Dam 18.5 feet; implementing the set of eight common management measures described above; constructing additional resident fish habitat in Shasta Lake and along the lower reaches of its tributaries (the Sacramento River, the McCloud River, and Squaw Creek); constructing shoreline fish habitat around Shasta Lake; augmenting spawning gravel in the upper Sacramento River; restoring riparian, floodplain, and side channel habitat in the upper Sacramento River; and increasing recreation opportunities at Shasta Lake. CP5 also includes implementing environmental commitments and mitigations measures. By raising Shasta Dam from a crest at elevation 1,077.5 to elevation 1,096.0 (NGVD29), in combination with spillway modifications, CP5 would increase the height of the reservoir's full pool by 20.5 feet, increasing the overall full pool storage from 4.55 MAF to 5.19 MAF.

Under CP5, the additional storage in Shasta Reservoir would be used to increase water supply reliability and to expand the cold-water pool for downstream anadromous fisheries. Enlarging Shasta Reservoir would increase the depth and volume of the cold-water pool, increasing the ability of Reclamation to release cold water from Shasta Dam and regulate seasonal water temperatures for fish in the upper Sacramento River during critical periods. This alternative (and all action alternatives) includes extending the existing TCD for efficient use of the expanded cold-water pool. CP5 would increase water supply reliability for agricultural, M&I, and environmental purposes. CP5 would also help reduce future water shortages through increasing irrigation and M&I deliveries, primarily during drought periods.

CP5 also addresses secondary planning objectives related to hydropower generation, recreation, flood damage reduction, ecosystem restoration, and water quality. Higher water surface elevations in the reservoir would result in an increase in power generation. CP5 includes features to at least maintain the existing recreation capacity at Shasta Lake, and water-oriented recreation experiences would be enhanced due to an increase in average lake surface area, reduced drawdown during the recreation season, and modernization of recreation facilities. Enlarging Shasta Dam would provide for incidental increased reservoir capacity to capture flood flows, which could reduce flood damage along the upper Sacramento River. Improved fisheries conditions as a result of CP5, and increased flexibility to meet flow and temperature requirements, could also enhance overall ecosystem resources in the Sacramento River. Additional storage in Shasta Reservoir would also provide improved operational flexibility for meeting Delta water quality objectives through increased and/or high-flow releases to improve Delta water quality.

Operations for water supply, hydropower, and environmental and other regulatory requirements would be similar to existing operations, except during dry and critical years when a portion of the increased storage in Shasta Reservoir would be reserved to specifically focus on increasing M&I deliveries. In dry years, 150,000 acre-feet of the 634,000 acre-feet increased storage capacity in Shasta Reservoir would be reserved for increasing M&I deliveries. In critical years, 75,000 acre-feet of the increased storage capacity would be reserved for increasing M&I deliveries.

S.6.7 Summary of Comprehensive Plan Physical Features and Benefits

The following sections describe the physical features and potential benefits of comprehensive plans (action alternatives) evaluated in this EIS.

Physical Features

Each of the comprehensive plans (action alternatives) involves raising Shasta Dam by 6.5 feet to 18.5 feet, increasing the storage capacity in Shasta Reservoir by 256,000 acre-feet to 634,000 acre-feet, and constructing a common set of features, as shown in Table S-1. Features and related construction activities under all comprehensive plans would include the following:

- Clearing vegetation from portions of the inundated reservoir area
- Constructing the dam, appurtenant structures, reservoir area dikes, and railroad embankments
- Relocating roadways, bridges, recreation facilities, utilities, and miscellaneous minor infrastructure

Table S-1. Summary of Physical Features of Action Alternatives

	Action Alternatives					
Main Features	**CP1**	**CP2**	**CP3**	**CP4**	**CP4A**	**CP5**
Dam and Appurtenant Structures						
Shasta Dam						
Crest Raise (feet)	6.5	12.5	18.5	18.5	18.5	18.5
Full Pool Height Increase (feet)	8.5	14.5	20.5	20.5	20.5	20.5
Elevation of Dam Crest (feet)[1]	1084.0	1090.0	1096.0	1096.0	1096.0	1096.0
Elevation of Full Pool (feet)[2]	1,078.2	1,084.2	1,090.2	1,090.2	1,090.2	1,090.2
Capacity Increase (acre-feet)	256,000	443,000	634,000	634,000	634,000	634,000
Main Dam	Raise dam crest. Construct new parapets and utility gallery. Raise existing elevator tower and hoist tower.	Raise dam crest. Construct new parapets and utility gallery. Raise existing elevator tower and hoist tower.	Raise dam crest. Construct new parapets and utility gallery. Raise existing elevator tower and hoist tower.	Raise dam crest. Construct new parapets and utility gallery. Raise existing elevator tower and hoist tower.	Raise dam crest. Construct new parapets and utility gallery. Raise existing elevator tower and hoist tower.	Raise dam crest. Construct new parapets and utility gallery. Raise existing elevator tower and hoist tower.
Wing Dams	Raise to meet dam crest. Build new visitor center along left wing dam. Relocate gantry crane on right wing dam.	Raise to meet dam crest. Build new visitor center along left wing dam. Relocate gantry crane on right wing dam.	Raise to meet dam crest. Build new visitor center along left wing dam. Relocate gantry crane on right wing dam.	Raise to meet dam crest. Build new visitor center along left wing dam. Relocate gantry crane on right wing dam.	Raise to meet dam crest. Build new visitor center along left wing dam. Relocate gantry crane on right wing dam.	Raise to meet dam crest. Build new visitor center along left wing dam. Relocate gantry crane on right wing dam.
Spillway	Raise crest and extend piers. Replace 3 drum gates with 6 sloping fixed-wheel gates.	Raise crest and extend piers. Replace 3 drum gates with 6 sloping fixed-wheel gates.	Raise crest and extend piers. Replace 3 drum gates with 6 sloping fixed-wheel gates.	Raise crest and extend piers. Replace 3 drum gates with 6 sloping fixed-wheel gates.	Raise crest and extend piers. Replace 3 drum gates with 6 sloping fixed-wheel gates.	Raise crest and extend piers. Replace 3 drum gates with 6 sloping fixed-wheel gates.
River Outlets	Replace 4 lower-tier tube valves with jet flow gates.	Replace 4 lower-tier tube valves with jet flow gates.	Replace 4 lower-tier tube valves with jet flow gates.	Replace 4 lower-tier tube valves with jet flow gates.	Replace 4 lower-tier tube valves with jet flow gates.	Replace 4 lower-tier tube valves with jet flow gates.
Temperature Control Device	Raise/modify controls.	Raise/modify controls.	Raise/modify controls.	Raise/modify controls.	Raise/modify controls.	Raise/modify controls.
Shasta Powerplant/ Penstocks	Raise penstock hoists.	Raise penstock hoists.	Raise penstock hoists.	Raise penstock hoists.	Raise penstock hoists.	Raise penstock hoists.
Pit 7 Dam/Powerhouse	Increase height of training walls on dam spillway. Install a tailwater depression system. Modify other Pit 7 ancillary facilities.	Increase height of training walls on dam spillway. Install a tailwater depression system. Modify other Pit 7 ancillary facilities.	Increase height of training walls on dam spillway. Install a tailwater depression system. Modify other Pit 7 ancillary facilities.	Increase height of training walls on dam spillway. Install a tailwater depression system. Modify other Pit 7 ancillary facilities.	Increase height of training walls on dam spillway. Install a tailwater depression system. Modify other Pit 7 ancillary facilities.	Increase height of training walls on dam spillway. Install a tailwater depression system. Modify other Pit 7 ancillary facilities.

Table S-1. Summary of Physical Features of Action Alternatives (contd.)

Main Features	CP1	CP2	CP3	CP4	CP4A	CP5
	Action Alternatives					
Reservoir Area Clearing	Clear 150 acres completely and 220 acres with overstory removal.	Clear 240 acres completely and 350 acres with overstory removal.	Clear 340 acres completely and 500 acres with overstory removal.	Clear 340 acres completely and 500 acres with overstory removal.	Clear 340 acres completely and 500 acres with overstory removal.	Clear 340 acres completely and 500 acres with overstory removal.
Reservoir Area Dikes and Railroad Embankments	Construct 3 railroad embankments and 2 new dikes.	Construct 3 railroad embankments and 3 new dikes.	Construct 3 railroad embankments and 4 new dikes.	Construct 3 railroad embankments and 4 new dikes.	Construct 3 railroad embankments and 4 new dikes.	Construct 3 railroad embankments and 4 new dikes.
Relocations						
Roadways	Match replacement widths to existing paved roads to be replaced.	Match replacement widths to existing paved roads to be replaced.	Match replacement widths to existing paved roads to be replaced.	Match replacement widths to existing paved roads to be replaced.	Match replacement widths to existing paved roads to be replaced.	Match replacement widths to existing paved roads to be replaced.
Length of Relocated Roadway (linear feet)	16,700	28,400	33,100	33,100	33,100	33,100
Number of Road Segments Affected	10	21	30	30	30	30
Vehicle Bridges	Relocate 4 bridges, modify 1 bridge.	Relocate 4 bridges, modify 1 bridge.	Relocate 4 bridges, modify 1 bridge.	Relocate 4 bridges, modify 1 bridge.	Relocate 4 bridges, modify 1 bridge.	Relocate 4 bridges, modify 1 bridge.
Railroad	Relocate 2 bridges and realign track in-between, modify 1 bridge	Relocate 2 bridges and realign track in-between, modify 1 bridge	Relocate 2 bridges and realign track in-between, modify 1 bridge	Relocate 2 bridges and realign track in-between, modify 1 bridge	Relocate 2 bridges and realign track in-between, modify 1 bridge	Relocate 2 bridges and realign track in-between, modify 1 bridge
Recreation Facilities	Modify or replace 9 marinas, 6 public boat ramps, 6 resorts, 202 campsites/day-use sites/RV sites, 2 USFS facilities, 8.1 miles of trail, and 2 trailheads.	Modify or replace 9 marinas, 6 public boat ramps, 6 resorts, 261 campsites/ day-use sites/RV sites, 2 USFS facilities, 9.9 miles of trail, and 2 trailheads.	Modify or replace 9 marinas, 6 public boat ramps, 6 resorts, 328 campgrounds/day-use areas/RV sites, 2 USFS facilities, 11.6 miles of trail, and 2 trailheads.	Modify or replace 9 marinas, 6 public boat ramps, 6 resorts, 328 campgrounds/day-use areas/RV sites, 2 USFS facilities, 11.6 miles of trail, and 2 trailheads.	Modify or replace 9 marinas, 6 public boat ramps, 6 resorts, 328 campgrounds/day-use areas/RV sites, 2 USFS facilities, 11.6 miles of trail, and 2 trailheads.	Modify or replace 9 marinas, 6 public boat ramps, 6 resorts, 328 campgrounds/day-use areas/RV sites, 2 USFS facilities, 11.6 miles of trail, and 2 trailheads. Add 6 trailheads and 18 miles of new hiking trails.
Utilities	Relocate inundated utilities. Construct wastewater treatment facilities.	Relocate inundated utilities. Construct wastewater treatment facilities.	Relocate inundated utilities. Construct wastewater treatment facilities.	Relocate inundated utilities. Construct wastewater treatment facilities.	Relocate inundated utilities. Construct wastewater treatment facilities.	Relocate inundated utilities. Construct wastewater treatment facilities.

Table S-1. Summary of Physical Features of Action Alternatives (contd.)

	Action Alternatives					
Main Features	**CP1**	**CP2**	**CP3**	**CP4**	**CP4A**	**CP5**
Ecosystem Enhancements	None	None	None	Reserve 378 TAF of the additional storage for cold-water supply for anadromous fish. Implement adaptive management plan to benefit anadromous fish. Augment spawning gravel in the upper Sacramento River at the rate of up to 10,000 tons per year. Restore riparian, floodplain, and side channel habitat along the upper Sacramento River.	Reserve 191 TAF of the additional storage for cold-water supply for anadromous fish. Implement adaptive management plan to benefit anadromous fish. Augment spawning gravel in the upper Sacramento River at the rate of up to 10,000 tons per year. Restore riparian, floodplain, and side channel habitat along the upper Sacramento River.	Construct shoreline fish habitat around Shasta Lake. Enhance aquatic habitat in tributaries to Shasta Lake to improve fish passage. Augment spawning gravel in the upper Sacramento River at the rate of up to 10,000 tons per year. Restore riparian, floodplain, and side channel habitat along the upper Sacramento River.

Notes:
[1] Dam crest elevations are based on the National Geodetic Vertical Datum of 1929 (NGVD29). All current feasibility-level designs and figures for Shasta Dam and appurtenant structures are based on NGVD29.
[2] Full pool elevations are based on the North American Vertical Datum of 1988 (NAVD88), which is 2.66 feet higher than NGVD29. All current feasibility-level designs and figures for reservoir area infrastructure modifications and relocations to accommodate increased water levels are based on a 2001 aerial survey of the reservoir using NAVD88.

Key:
CP = comprehensive plan
RV = recreational vehicle
TAF = thousand acre-feet
USFS = U.S. Department of Agriculture, Forest Service

CP4, CP4A, and CP5 would also include features and related construction activities associated with gravel augmentation and restoring riparian, floodplain, and side channel habitat along the upper Sacramento River. Additional features and related construction activities associated with Shasta Lake and tributary shoreline enhancements and features to increase Shasta Lake recreation opportunities are included under CP5. Figure S-5 illustrates major features in the Shasta Lake area common to all comprehensive plans.

Benefits

For all of the comprehensive plans, the additional storage would be used to increase the ability of Reclamation to regulate water temperatures for anadromous fish and increase water supply reliability, primarily in drought periods. Table S-2 summarizes the potential benefits for each project objective for each comprehensive plan. As shown in Table S-2, each of the comprehensive plans would contribute in varying degrees to all of the primary and secondary planning objectives.

S.7 Alternatives Considered and Eliminated

Formulation of a range of alternatives for evaluation in this feasibility study began with a review of problems, needs, and opportunities identified and defined previously, study authorities, and other pertinent direction, followed by development of primary and secondary planning objectives, and, finally, development of comprehensive plans (action alternatives) to meet the project purpose and need. Some project alternatives suggested during this process (e.g., raising Shasta Dam by up to 200 feet) were not retained because they did not adequately meet, or were beyond the scope of, the purpose and need statement, did not contribute to both primary planning objectives, had extremely high costs, had high social or environmental impacts, or were previously analyzed in or rejected from consideration by the CALFED agencies in the CALFED PEIS/R.

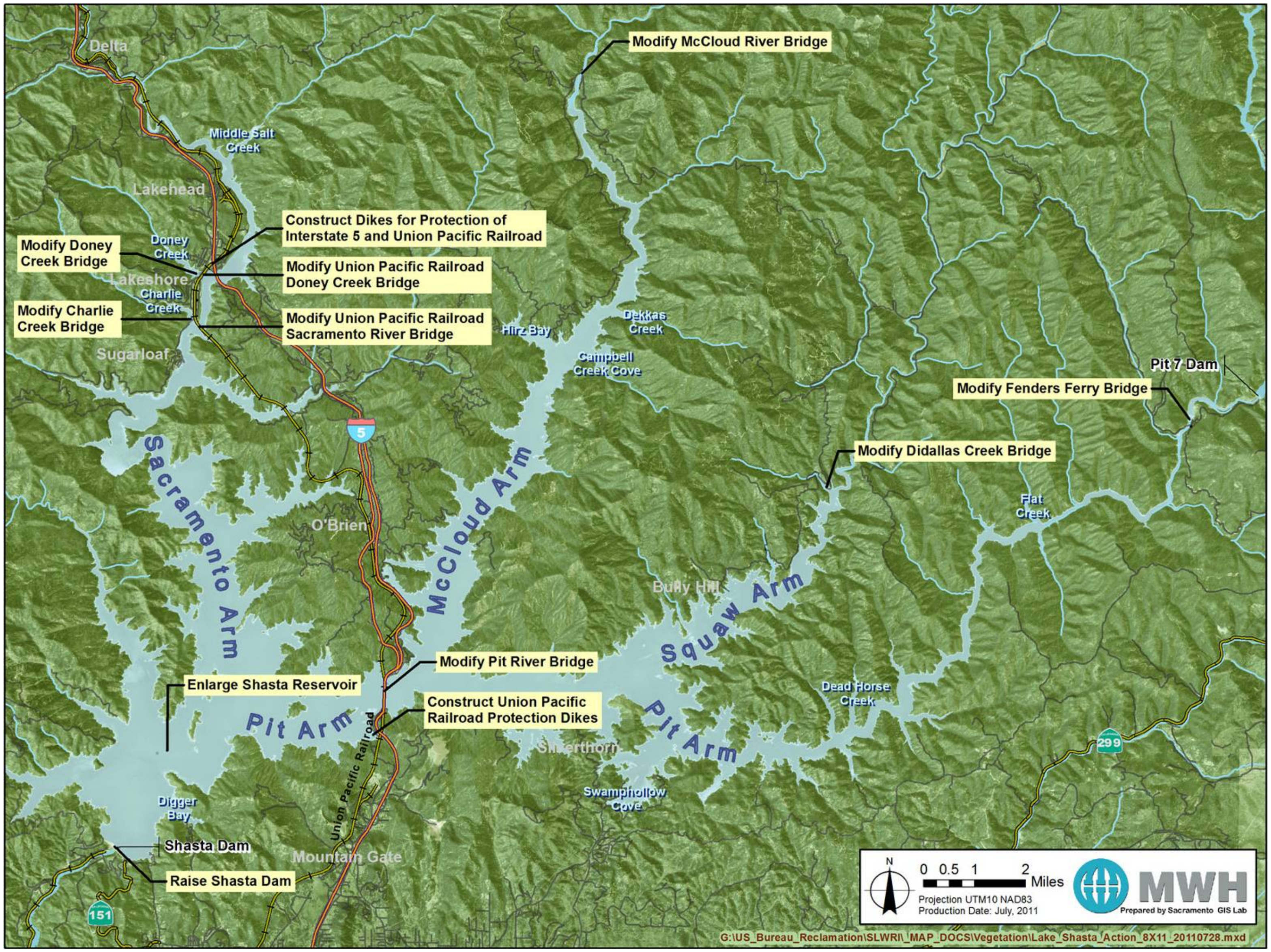


Figure S-5. Major Features Common to All Action Alternatives

Table S-2. Summary of Major Potential Benefits of Action Alternatives

Item	CP1	CP2	CP3	CP4	CP4A	CP5
Shasta Dam Raise (feet)	**6.5**	**12.5**	**18.5**	**18.5**	**18.5**	**18.5**
Total Increased Storage (TAF)	256	443	634	634	634	634
Benefits Related to Project Objectives						
Increase Anadromous Fish Survival						
Dedicated Storage (TAF)	-	-	-	378	191	-
Production Increase (thousand fish)[1]	61	379	207	813	710	378
Spawning Gravel Augmentation (tons)[2]				10,000	10,000	10,000
Side Channel Rearing Habitat Restoration				Yes	Yes	Yes
Increase Water Supply Reliability						
Total Increased Dry and Critical Year Water Supplies (TAF/year)[3]	47.3	77.8	63.1	47.3	77.8	113.5
Increased NOD Dry and Critical Year Water Supplies (TAF/year)[3]	4.5	10.7	35.2	4.5	10.7	25.2
Increased SOD Dry and Critical Year Water Supplies (TAF/year)[3]	42.7	67.1	28.0	42.7	67.1	88.3
Increased Water Use Efficiency Funding	Yes	Yes	Yes	Yes	Yes	Yes
Increased Emergency Water Supply Response Capability	Yes	Yes	Yes	Yes	Yes	Yes
Reduce Flood Damage						
Increased Reservoir Storage Capacity	Yes	Yes	Yes	Yes	Yes	Yes
Additional Hydropower Generation[4]						
Increased Hydropower Generation (GWh/year)[5]	52 - 54	87 - 90	86 - 90	127 - 133	125 - 130	112 - 117
Conserve, Restore, and Enhance Ecosystem Resources						
Shoreline Enhancement (acres)	-	-	-	-	-	130
Tributary Aquatic Habitat Enhancement (miles)[6]	-	-	-	-	-	6
Riparian, Floodplain, and Side Channel Restoration Habitat	-	-	-	Yes	Yes	Yes
Increased Ability to Meet Flow and Temperature Requirements Along Upper Sacramento River	Yes	Yes	Yes	Yes	Yes	Yes
Improve Water Quality						
Improved Delta Water Quality	Yes	Yes	Yes	Yes	Yes	Yes
Increased Delta Emergency Response Capability	Yes	Yes	Yes	Yes	Yes	Yes
Increase Recreation						
Recreation (user days, thousands)[7]	85 - 89	116 - 134	201 - 205	307 - 370	246 - 259	142 - 175
Modernization of Recreation Facilities	Yes	Yes	Yes	Yes	Yes	Yes

Table S-2. Summary of Major Potential Benefits of Action Alternatives (contd.)

Notes:

1 Numbers were derived from SALMOD and represent an index of production increase, based on the estimated average annual increase in juvenile Chinook salmon surviving to migrate downstream from Red Bluff Pumping Plant.

2 Average amount per year for 10-year period.

3 Total drought period reliability for Central Valley Project and State Water Project deliveries. Does not reflect benefits related to water use efficiency actions included in all comprehensive plans.

4 In addition to increased hydropower generation, all comprehensive plans provide increased capacity benefits (i.e., the rate at which power can be generated) and ancillary services, which provide the ability to manage the electric grid in a reliable manner.

5 Annual increased in hydropower generation were estimated using two methodologies – at load center (accounting from transmission losses) and at-plant (no transmission losses). To provide a more conservation estimate of potential hydropower benefits, load center generation values were used to estimate potential benefits of increased hydropower generation under comprehensive plans. However, increased generation values reported in Chapter 23, "Power and Energy," of this EIS are based on at-plant generation values to capture the largest potential effects from changes in hydropower generation and pumping.

6 Tributary aquatic enhancement provides for the connectivity of native fish species and other aquatic organisms between Shasta Lake and its tributaries. Estimates of benefits reflect only connectivity with perennial streams and do not reflect additional miles of connectivity with intermittent streams.

7 Annual recreation visitor user days were estimated using two methodologies. The minimum user day value was used to estimate potential recreation benefits to provide a more conservative estimate of the potential benefits of increased recreation under comprehensive plans. However, the maximum user value was used for direct and indirect effects evaluations in each resource area chapter to capture the largest potential effects from increased visitation. These values do not account for increased visitation due to modernization of recreation facilities associated with all comprehensive plans. For more detailed information related to estimated recreation user days, please see Chapter 10, "Recreational Visitation," of the Modeling Appendix.

Key:

- = not applicable
CP = comprehensive plan
Delta = Sacramento-San Joaquin Delta
GWh/year = gigawatt-hours per year
NOD = north of Delta
SOD = south of Delta
TAF = thousand acre feet

S.8 Preferred Alternative and Rationale for Selection

A plan recommending Federal action should be the plan that best addresses the targeted water resources problems considering public benefits relative to costs. It is recognized that most of the activities pursued by the Federal Government will require assessing trade-offs by decision makers and that in many cases, the final decision will require judgment regarding the appropriate extent of monetized and nonmonetized effects.

NEPA CEQ Regulations require the identification of the alternative or alternatives that are environmentally preferable in the ROD (40 CFR 1505.2(b)). The environmentally preferable alternative generally refers to the alternative that would result in the fewest adverse effects to the biological and physical environment. It is also the alternative that would best protect, preserve, and enhance historic, cultural, and natural resources. Although this environmentally preferable alternative must be identified in the ROD, it need not be selected for implementation. For the purposes of NEPA, an environmentally preferable alternative will be identified in the ROD associated with this EIS.

The preferred alternative has been identified in the Final EIS in consideration of public, stakeholder, and agency comments on the DEIS. The alternative recommended for implementation may or may not be identified as the "Environmentally Preferable Alternative" consistent with NEPA, the "Least

Environmentally Damaging Practicable Alternative" consistent with the Clean Water Act, and the "Environmentally Superior Alternative" consistent with CEQA.

Consistent with the above CEQ Regulations and NEPA guidelines, the preferred alternative for implementation has been identified in the Final EIS, as described in the following section.

S.8.1 Preferred Alternative

Each of the action alternatives – CP1, CP2, CP3, CP4, CP4A, and CP5 – includes enlarging Shasta Dam and Reservoir and a variety of management measures to address, in varying degrees, all of the project objectives. The major benefits of the action alternatives are summarized in Table S-2, and the impacts and mitigation measures are summarized in Table S-3. The cost estimates are presented in the Engineering Summary Appendix, Attachment 1, "Cost Estimates for Comprehensive Plans."

In the action alternatives, dam raises of three different heights were evaluated – 6.5 feet, 12.5 feet, and 18.5 feet. While all action alternatives provide benefits for the identified primary and secondary project objectives (to varying degrees), the overall benefits of an 18.5-foot raise (CP3, CP4, CP4A, or CP5) were found to be greater than those of either a 6.5-foot raise (CP1) or 12.5-foot raise (CP2). Therefore, only the 18.5-foot raise action alternatives were retained as possibilities for the preferred alternative. For example, the additional reservoir storage would increase from 256,000 acre-feet with the 6.5-foot raise to 634,000 acre-feet with the 18.5-foot raise – nearly 2.5 times the additional reservoir storage of the 6.5-foot raise for between 15-25 percent greater construction costs. This additional reservoir storage space would support both water supply reliability and fisheries objectives.

Reservoir operations and the resulting benefits were the differentiators amongst the 18.5-foot raise action alternatives (CP3, CP4, CP4A, or CP5). For example, CP3 would maximize agricultural water supply reliability, but would be the least beneficial to fisheries of the 18.5-foot raises. CP4 would provide the best opportunity to address anadromous fish survival in the upper Sacramento River; however, CP4 would provide the lowest benefits to water supply reliability.

Below is a summary of each action alternative weighed by Reclamation during the selection of a preferred alternative.

- CP1, formulated to address both anadromous fish survival and water supply reliability, would result in the lowest benefits of all of the action alternatives. Greater project benefits should be realized with higher dam raises for relatively low increases in costs. Therefore, CP1 was not selected as the preferred alternative.

- CP2, formulated to address both anadromous fish survival and water supply reliability, would have relatively low benefits when compared to the other action alternatives. Greater project benefits should be realized with higher dam raises for relatively low increases in costs. Therefore, CP2 was not selected as the preferred alternative.

- CP3, formulated to address both agricultural water supply reliability and anadromous fish survival, would greatly increase agricultural water supply reliability. However, CP3 would have no M&I water supply benefits and very low anadromous fish survival benefits when compared to the other 18.5-foot raises. Therefore, CP3 was not selected as the preferred alternative.

- CP5, formulated as a combination plan focusing on all objectives, would greatly increase water supply reliability. However, CP5 would have relatively low increased anadromous fish survival benefits in comparison with all other 18.5-foot raises. Therefore, CP5 was not selected as the preferred alternative.

- CP4, formulated to focus on anadromous fish survival while increasing water supply reliability, would have the highest increase in anadromous fish survival of all of the alternatives and the lowest increase in water supply reliability compared to all of the considered alternatives (equal to CP1). CP4 would not best meet both of the primary objectives; water supply reliability would be compromised for increased anadromous fish survival. Therefore, CP4 was not selected as the preferred alternative. However, the evaluation of CP4 did indicate that refinements of operations could be made to optimize the amount of water supply targeted for anadromous fish survival and water supply reliability such that both primary objectives could be substantially achieved with an 18.5-foot raise. This evaluation provided the impetus for Reclamation to develop CP4A, which performs better at simultaneously meeting both the anadromous fish survival and water reliability primary objectives.

CP4A would best balance and meet both of the primary objectives. CP4A, formulated to address both anadromous fish survival and water supply reliability, would have relatively high increases in water supply reliability (equal to CP2) and the second highest increase in anadromous fish survival of all of the alternatives. CP4A would have the ability to meet the secondary project objectives, which were considered to the extent possible through pursuit of the primary project objectives. Secondary objectives include ecosystem enhancement, flood damage reduction, improved Delta water quality, increased hydropower generation and increased recreation. As an 18.5-foot raise, CP4A would best maximize benefits relative to costs. For these reasons, CP4A is the preferred alternative.

S.9 Major Conclusions of Environmental Analysis

An environmental document prepared to comply with NEPA must consider the context and intensity of the environmental effects that would be caused by, or result from, the proposed action. Under NEPA, the significance of an effect is a determining factor in whether an EIS must be prepared. An environmental document prepared to comply with CEQA must identify the significance of the environmental effects of a proposed project. As stated in State CEQA Guidelines, Section 15382, a "'[s]ignificant effect on the environment' means a substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by the project…"

S.9.1 Methods and Assumptions

This EIS analyzes the direct and indirect effects of the No-Action Alternative and action alternatives for each environmental resource area. Direct effects are those that would be caused by the action and would occur at the same time and place. Indirect effects are reasonably foreseeable consequences that may occur at a later time or at a distance from the project area. Examples of indirect effects are growth inducement and other effects related to changes in land use patterns, population density, or growth rate, and related effects on the physical environment.

The effects of the No-Action Alternative and action alternatives were determined by comparing estimates of resulting conditions with baseline conditions. These baseline conditions differ between NEPA and CEQA. Under NEPA, the No-Action Alternative (i.e., expected future conditions without the project) is the baseline to which the action alternatives are compared; the No-Action Alternative is also compared to existing conditions. Under CEQA, existing conditions are the baseline to which alternatives are compared.

CVP and SWP Operational Assumptions

Reclamation and DWR use CalSim-II, a specific application of the Water Resources Integrated Modeling System (WRIMS) to Central Valley water operations, to study operations, benefits, and effects of new facilities and operational parameters for the CVP and SWP. In this EIS, the quantitative assessment of actions related to water resources relied primarily on two CalSim-II baselines for CEQA and NEPA:

- "Existing cconditions," based on a 2005 level of development and current facilities, as defined in 2012 (a 2005 baseline)

- "Future cconditions," based on without-project forecasted 2020-2030 level of development and reasonably foreseeable future projects and facilities (a 2030 baseline)[3]

Operational assumptions for refinement, modeling, and evaluation of potential effects of the No-Action Alternative and action alternatives included in this EIS were derived from the 2008 Long-Term Operation BA, the 2008 USFWS BO, the 2009 NMFS BO, and the Coordinated Operations Agreement between Reclamation and DWR for the CVP and SWP, as ratified by Congress (Reclamation and DWR 1986).

Despite the uncertainty resulting from ongoing consultation processes, the 2008 Long-Term Operation BA and the 2008 and 2009 BOs issued by the fishery agencies contain the most recent estimate of potential changes in water operations that could occur in the near future. If the revised USFWS and NMFS BOs contain new or amended reasonable and prudent alternatives (RPA), such requirements may result in changes to CVP and SWP operational constraints.

Climate Change

CEQ guidance, issued February 18, 2010, suggests that Federal agencies consider opportunities to reduce greenhouse gas (GHG) emissions caused by proposed Federal actions, adapt their actions to climate change impacts throughout the NEPA process, and address these issues in the agencies' NEPA procedures. Following are the main factors to consider when addressing climate change in environmental documentation:

- Effects of a proposed action and alternative actions on GHG emissions

- Impacts of climate change on a proposed action or alternatives

CEQ notes that "significant" national policy decisions with "substantial" GHG impacts require analysis of their GHG effects. That is, the GHG effects of a Federal agency's proposed action must be analyzed if the action would cause "substantial" annual direct emissions; would implement energy conservation or reduced energy use or GHG emissions; or would promote cleaner, more efficient renewable-energy technologies.

Each resource area analyzed in the EIS evaluates the effects the action alternatives and No-Action Alternative combined with predicted effects of climate change. The ways that the SLWRI could affect GHG production are

[3] The level of development used for future conditions is a composite of multiple land use scenarios developed by DWR and Reclamation. The Sacramento Valley hydrology, which includes the Sacramento and Feather River basins, is based on projected 2020 land use assumptions associated with DWR Bulletin 160-98 (1998) and the San Joaquin Valley hydrology is based on the 2030 land use assumptions developed by Reclamation. Under any 2020 to 2030 level of development scenario, the majority of the CVP and SWP unmet demand is located south of the Delta, including the San Joaquin Valley. Please see Table 2-1 in the Modeling Appendix for additional information on CalSim-II modeling assumptions.

also addressed. The Climate Change Modeling Appendix provides a summary of global climate forecasts and a discussion of the implications of climate change for California water resources. This appendix also includes quantitative analyses of climate change for selected comprehensive plans on resource areas. The discussion of climate change implications provided in the Climate Change Modeling Appendix provides context for consideration of cumulative conditions.

S.9.2 Summary of Impacts

The action alternatives would affect environmental resources in the primary and extended study areas. Some of the impacts would be temporary, construction-related effects that would be less than significant or would be reduced to less-than-significant levels through mitigation. Other impacts would be permanent, some of which would remain significant and unavoidable despite proposed mitigation measures. In addition, some effects of the project would be beneficial. Under CEQA, potentially significant impacts are treated as significant impacts. Therefore, consistent with CEQA, unless feasible mitigation measures have been identified to reduce the magnitude of a significant or potentially significant impact to less than significant, the level of significance after mitigation is considered significant and unavoidable.

Table S-3, included at the end of this Summary, summarizes the environmental impacts of the action alternatives, the duration and quantification of each impact, the level of significance of each impact before mitigation, recommended mitigation measures, and the level of significance of each impact after mitigation.

S.9.3 Significant and Unavoidable Impacts

As shown in Table S-3, after consideration of actions, operations, and features to avoid, mitigate, and/or compensate for adverse effects, the action alternatives would likely result in the following significant and unavoidable direct and indirect impacts:

- **Geology, Geomorphology, Minerals, and Soils –** Loss or diminished availability of known mineral resources that would be of future value to the region; lost or diminished soil biomass productivity; and substantial soil erosion or loss of topsoil due to shoreline processes (all action alternatives).

- **Air Quality and Climate –** Short-term emissions of criteria air pollutants and precursors at Shasta Lake and vicinity during project construction (all action alternatives).

- **Agriculture and Important Farmland –** Direct and indirect conversion of forest land to nonforest uses in the vicinity of Shasta Lake (all action alternatives).

- **Botanical Resources and Wetlands** – Loss of Multi-Species Conservation Strategy covered species; loss of USFS sensitive, U.S. Department of Interior, Bureau of Land Management, sensitive, or California Rare Plant Rank species; loss of jurisdictional waters; and loss of general vegetation habitats (all action alternatives).

- **Wildlife Resources** – Take and loss of habitats for the Shasta salamander, bald eagle, northern spotted owl, and Pacific fisher; impact on the foothill yellow-legged frog, tailed frog, northwestern pond turtle, purple martin, special-status bats, American marten, ringtail, terrestrial mollusks, and their habitat; impact on willow flycatcher, Vaux's swift, yellow warbler, yellow-breasted chat, long-eared owl, northern goshawk, Cooper's hawk, great blue heron, and osprey, and their foraging and nesting habitat; permanent loss of general wildlife habitat; take and loss of foraging and nesting habitat for other birds of prey and migratory bird species; and loss of critical deer winter and fawning range (all action alternatives).

- **Cultural Resources –** Inundation of Traditional Cultural Properties (all action alternatives).

- **Land Use and Planning –** Conflict with existing land use goals and policies of affected jurisdictions (Shasta Lake and vicinity and upper Sacramento River), and disruption of existing land uses (Shasta Lake and vicinity and upper Sacramento River) (all action alternatives).

- **Aesthetics and Visual Resources –** Inconsistency with guidelines for visual resources in the USFS 1995 Shasta-Trinity National Forest Land and Resource Management Plan, degradation and/or obstruction of a scenic view from key observation points, and generation of increased daytime glare and/or nighttime lighting (all action alternatives).

- **Wild and Scenic River Considerations for McCloud River –** Effect on McCloud River's eligibility for listing as a Federal Wild and Scenic River and effects to McCloud River resources identified in the California Public Resources Code, Section 5093.542 (all action alternatives).

The action alternatives could also result in the following significant and unavoidable cumulative impacts (i.e., an impact would make a considerable contribution to a significant cumulative effect):

- **Geology, Geomorphology, Minerals, and Soils –** Cumulative effects from use of soil and mineral resources, leading to diminished regional availability of cement, concrete sand, and aggregate and loss of soil productivity (all action alternatives).

- **Air Quality and Climate –** Cumulative effects from emissions of nitrous oxide (NO_x) during project construction (all action alternatives).

- **Hydrology, Hydraulics, and Water Management –** Cumulative effects on south Delta water levels, X2 position, and Delta outflow (all action alternatives).

- **Botanical Resources and Wetlands –** Cumulative effects from inundation at Shasta Lake, leading to take and loss of habitat for special-status species at Shasta Lake and vicinity; cumulative effects from increased water delivery in the service areas and growth-related loss of sensitive plant communities and special-status plant species (all action alternatives).

- **Wildlife Resources –** Cumulative effects from inundation at Shasta Lake, leading to take and loss of habitat for numerous special-status species at Shasta Lake and vicinity (all action alternatives).

- **Cultural Resources –** Inundation of Traditional Cultural Properties (all action alternatives).

- **Power and Energy Resources –** Changes to net energy values due to energy use for CVP and SWP pumping, and loss of generation (CP1).

- **Aesthetics and Visual Resources –** Changes to aesthetic values and resources at Shasta Lake (all action alternatives).

- **Environmental Justice –** Cumulative effects from disproportionate placement of environmental impacts on Native American populations, leading to disturbance or loss of resources associated with locations considered by the Winnemem Wintu and Pit River Madesi Band members to have religious and cultural significance in the vicinity of Shasta Lake (all action alternatives).

S.9.4 Environmental Commitments

As part of project planning and environmental assessment, Reclamation has incorporated certain environmental commitments and best management practices into the action alternatives to avoid or minimize potential impacts. Reclamation will also coordinate planning, engineering, design and construction, operation, and maintenance phases of the any authorized project modifications with applicable resource agencies and potentially affected public and private landowners, communities, and individuals.

The following environmental commitments would be incorporated into any action alternative for any project-related construction activities:

- Develop and implement a construction management plan to avoid or minimize potential impacts to public health and safety during project construction (e.g., procedures for stockpiling and staging, public access routes, and construction notification).

- Comply with applicable laws, policies, and plans for this project, including all terms and conditions of all required project permits, approvals, and conditions attached thereto.

- Provide relocation assistance services for displaced individuals, families, businesses, and private property owners in accordance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended.

- Remain consistent with USFS Built Environment Image Guide for any facilities subject to USFS authorization that are constructed or reconstructed facilities.

- Protect all Public Land Survey System monuments and associated references and all property corners, either by positioning, or, where necessary, creating new references.

- Evaluate and protect paleontological resources discovered during construction.

- Develop and implement a stormwater pollution prevention plan to prevent or minimize the discharge of sediments and other contaminants with the potential to affect beneficial uses or lead to violations of water quality objectives of surface waters.

  – Develop and implement an erosion and sediment control plan to control short-term and long-term erosion and sedimentation effects, and to stabilize soils and vegetation in areas affected by construction activities.

  – Develop and implement a feasible spill prevention and hazardous materials management plan to minimize effects from spills of hazardous, toxic, or petroleum substances for project-related activities occurring in or near waterways.

- Implement efforts to minimize potential adverse effects to water quality, including:

  – Implement in-water construction work windows to occur when instream flows are managed outside the flood season (e.g., June 15 to September 15).

   - Comply with all additional requirements specified in permits relating to water quality protection.
   - Implement best management practices (BMP) to avoid and/or minimize potential impacts to water quality associated with construction and the 10-year-long spawning gravel augmentation program. These BMPs include:
      - Handle spawning gravel to minimize potential water quality impact.
      - Minimize potential impacts associated with equipment contaminants.
      - Implement feasible spill prevention and hazardous materials management.
      - Minimize potential impacts associated with access and staging.
      - Remove temporary fills as appropriate.
      - Remove equipment from river overnight and during high flows.
- Extend and enhance existing fish habitat structures in Shasta Lake through the placement of manzanita brush structures and vegetation cleared for construction to maintain shallow water and transitional riverine habitat.
- Maintain shallow-water and transitional riverine habitat with placement of manzanita brush structures, large woody debris, and rock-boulder clusters for established USFS habitat program.
- Implement fisheries conservation efforts to minimize potential adverse effects on fish species, including:
   - Implement in-water construction work windows to occur when sensitive fish species are not present, or would be least susceptible to disturbance. In-river work between Keswick Dam and the RBPP would be conducted to minimize impacts to Sacramento River winter-run Chinook salmon, i.e., mid-August through September.
   - Monitor potential impacts to important fishery resources throughout all phases of project construction.
   - Perform fish rescue/salvage for fish entrapped within construction structures and cofferdam enclosures, and stop construction activities for spawning activities for sensitive fish species.

  - Prepare a letter report detailing the methodologies used and the findings of fish monitoring and rescue efforts.

- Survey and monitor fish migration between Shasta Lake and Squaw Creek to determine if warm-water fish (bass) actively migrate into and cause adverse effects on native fish, amphibians, and mollusks.

- Prepare a comprehensive revegetation plan to be implemented in conjunction with other management plans (e.g., erosion and sediment control plan).

- Develop and require implementation of a control plan to prevent the introduction of zebra/quagga mussels, invasive plants, and other invasive species to project areas.

- Prepare and implement a fire protection and prevention plan to minimize the risk of wildfire or threat to workers, property, and the public.

- Recycle or reuse demolished construction materials where practical. To reduce risk associated with exposure to hazardous materials and waste:

  - Implement a Hazardous Materials Business Plan (HMBP) to provide information regarding hazardous materials to be used for project implementation and hazardous waste that may be generated.

  - Dispose of soil at a landfill or recycling facilities, transported by a licensed waste hauler.

  - Review all relevant available asbestos survey and abatement reports and supplemental asbestos surveys. Removal and disposal of asbestos-containing materials would be performed in accordance with applicable Federal, State, and local regulations.

  - Conduct a lead-based paint survey to determine areas where lead-based paint is present and the possible need for abatement before construction.

- Demolish and remove all asphaltic roadways and parking lots inundated by the proposed Shasta Dam raise, per California Fish and Game Code 5650 Section (a).

The environmental commitment section of the DEIS included a commitment to develop and implement a mitigation plan to minimize potential impacts to physical, biological, and socioeconomic resources. In conjunction with an interagency, interdisciplinary team, Reclamation refined and enhanced the mitigation measures, including development of a framework to quantify impacts (where appropriate) and establish mitigation ratios that were applicable to a number of impacts related to biological resources. The result of the development of the mitigation plan is documented in the Preliminary Environmental Commitments and Mitigation Plan (an appendix to this EIS).

S.10 Areas of Controversy

Federal, State, and local stakeholders identified several areas of controversy during SLWRI public outreach activities, including public scoping activities, agency meetings and workshops, and related ongoing stakeholder outreach activities. Key topics include potential adverse effects on cultural resources in the Shasta Lake area; recreation and recreation providers in the Whiskeytown-Shasta-Trinity NRA; the lower McCloud River and its special designation under California Public Resources Code Section 5093.542(c); impacts on reservoir area property owners; terrestrial special-status species around Shasta Lake, including State-designated fully protected species; fishery and riparian habitat resources along the upper Sacramento River; aquatic special-status species in the Sacramento River and Delta (including delta smelt); Delta water quality and south Delta water levels; Central Valley hydrology below CVP and SWP facilities and resulting effects on water supplies for water contractors and other water users; and assumptions on CVP and SWP regulatory constraints based on the 2008 USFWS BO and 2009 NMFS BO (discussed above).

S.11 Public Involvement and Next Steps

In accordance with NEPA review requirements, the DEIS was released for public and agency review and comment for a 90-day period. The comment period on the DEIS began on July 1, 2013, and closed on September 30, 2013. Written and verbal comments on the DEIS were accepted at three public workshops and three public hearings, and written comments were accepted throughout the comment period.

More than 5,000 comments were received on the DEIS from elected officials; federal, state, and tribal governments; regional and local governments and agencies; special interest groups, and individuals. The public comments have been reviewed and, in accordance with NEPA CEQ Regulations, responses have been developed for all substantive comments and revision of the DEIS have been made to clarify and enhance the text to produce this Final EIS.

Reclamation posted the Final EIS at http://www.usbr.gov/mp/slwri for public review and issued a notice in the Federal Register and a press release of the Final EIS. Also, elected officials and representatives, government agencies, private organizations, businesses, and individual members of the public on the mailing list have received a copy of this document or a notification of document availability.

The Final EIS and Final Feasibility Report will be used together to support the Federal decision. Typically, a ROD is the final step in the NEPA process and would document any decision on which actions, if any, to take to address the primary objectives.

The Final EIS, Final Feasibility Report, and supporting documents will be submitted by the Principal Deputy Commissioner of Reclamation to the Secretary of the Interior. After review by the Office of Management and Budget, in accordance with Executive Order 12322, the Secretary will transmit a Final EIS and Final Feasibility Report to the U.S. Congress to determine the type and extent of Federal interest in enlarging Shasta Dam and Reservoir if a plan is recommended for implementation. The proposed project would be considered for authorization by Congress and, if authorized, a separate appropriation authorization would be required. The project would be considered for inclusion in the President's budget based on (1) national priorities, (2) magnitude of the Federal commitment, (3) level of local support, (4) willingness of the non-Federal sponsor to fund its share of the project costs, and (5) budgetary constraints that may exist at the time of construction.

While this Final EIS has been prepared in consideration of CEQA requirements, to-date, formal CEQA scoping has not been initiated. This process may commence if and when a State lead agency is identified.

Table S-3. Summary of Impacts and Mitigation Measures

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Geology, Geomorphology, Minerals, and Soils						
Impact Geo-1: Exposure of Structures and People to Geologic Hazards Resulting from Seismic Conditions, Slope Instability, and Volcanic Eruptions	N-A	NA	–	NI	NA	NI
	CP1–CP5	Long-term	Pool level increase would inundate 78 acres (CP1), 110 acres (CP2), or 173 acres (CP3, CP4,CP4A and CP5) of mapped slope instability hazard	LTS	No mitigation needed; thus, none proposed.	LTS
Impact Geo-2: Alteration of Fluvial Geomorphology and Hydrology of Aquatic Habitats	N-A	NA	–	NI	NA	NI
	CP1–CP5	Long-term	–	S	Mitigation Measure Geo-2: Replace Lost Ecological Functions of Aquatic Habitats by Restoring Existing Degraded Aquatic Habitats in the Vicinity of the Impact.	LTS
Impact Geo-3: Loss or Diminished Availability of Known Mineral Resources That Would Be of Future Value to the Region	N-A	NA	–	NI	NA	NI
	CP1–CP5	Long-term	–	S	No feasible mitigation is available to reduce impact.	SU

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Geo-4: Lost or Diminished Soil Biomass Productivity	N-A	NA	–	NI	NA	NI
	CP1	Long-term	Loss of 1,954.6 acres of moderate productivity land; 1604.5 acres of low productivity land; 565 acres of nonproductive land	S	No feasible mitigation is available to reduce impact.	SU
	CP2	Long-term	Loss of 2,128 acres of moderate productivity land; 1,751 acres of low productivity land; 638 acres of nonproductive land	S	No feasible mitigation is available to reduce impact.	SU
	CP3–CP5	Long-term	Loss of 2,301 acres of moderate productivity land; 2,092 acres of low productivity land; 760 acres of nonproductive land	S	No feasible mitigation is available to reduce impact.	SU
Impact Geo-5: Substantial Soil Erosion or Loss of Topsoil Due to Shoreline Processes	N-A	NA	–	NI	NA	NI
	CP1	Short-term and long-term	Soil erosion of approximately 421,000 cubic yards per year for the first 15 years	S	No feasible mitigation is available to reduce impact.	SU
	CP2	Short-term and long-term	Soil erosion of approximately 549,000 cubic yards per year for the first 15 years	S	No feasible mitigation is available to reduce impact.	SU
	CP3-CP5	Short-term and long-term	Soil erosion of approximately 767,000 cubic yards per year for the first 15 years	S	No feasible mitigation is available to reduce impact.	SU
Impact Geo-6: Substantial Soil Erosion or Loss of Topsoil Due to Upland Processes	N-A	NA	–	NI	NA	NI
	CP1–CP5	Long-term	Up to approximately 3,340 acres in the upland portion of the Shasta Lake and vicinity area could be disturbed	LTS	No mitigation needed; thus, none proposed.	LTS

Notes:
1 Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
2 NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
3 NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
4 LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
5 NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Geo-7: Be Located on a Geologic Unit or Soil that Is Unstable, or that Would Become Unstable as a Result of the Project, and Potentially Result in Subsidence	N-A	NA	–	NI	NA	NI
	CP1–CP5	Long-term	–	LTS	No mitigation needed; thus, none proposed.	LTS
Impact Geo-8: Failure of Septic Tanks or Alternative Wastewater Disposal Systems Due to Soils that are Unsuited to Land Application of Waste	N-A	NA	–	NI	NA	NI
	CP1–CP5	Long-term	–	LTS	No mitigation needed; thus, none proposed.	LTS
Impact Geo-9: Substantial Increase in Channel Erosion and Meander Migration	N-A	Long-term	–	NI	NA	NI
	CP1–CP5	Long-term	–	LTS	Mitigation Measure Geo-9: Modification of Flow Releases in Response to River Management and Habitat Restoration Efforts between Keswick Dam and Red Bluff.	LTS
Impact Geo-10: Substantial Soil Erosion or Loss of Topsoil Due to Construction	N-A	NA	–	NI	NA	NI
	CP1–CP3	Short-term	–	NI	No mitigation needed; thus, none proposed.	NI
	CP4–CP5	Short-term	–	LTS	No mitigation needed; thus, none proposed.	LTS
Impact Geo-11: Alteration of Fluvial Geomorphology	N-A	NA	–	NI	NA	NI
	CP1–CP3	Long-term	–	NI	No mitigation needed; thus, none proposed.	NI
	CP4–CP5	Long-term	–	LTS	No mitigation needed; thus, none proposed.	LTS

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Geo-12: Alteration of Downstream Tributary Fluvial Geomorphology Due to Shasta Dam Operations	N-A	NA	–	NI	NA	NI
	CP1–CP5	Long-term	–	LTS	No mitigation needed; thus, none proposed.	LTS
Impact Geo-13: Substantial Increase in Channel Erosion and Meander Migration (Lower Sacramento River and Delta)	N-A	NA	–	NI	NA	NI
	CP1–CP5	Long-term	–	LTS	No mitigation needed; thus, none proposed.	LTS
Impact Geo-14: Substantial Increase in Channel Erosion and Meander Migration (CVP/SWP Service Areas)	N-A	NA	–	NI	NA	NI
	CP1–CP5	Long-term	–	LTS	No mitigation needed; thus, none proposed.	LTS
Air Quality and Climate						
Impact AQ-1: Short-Term Emissions of Criteria Air Pollutants and Precursors at Shasta Lake and Vicinity During Project Construction	N-A	NA	–	NI	NA	NI
	CP1–CP5	Short-term	NO_X emissions >137 lb/day, possible ROG & PM_{10} emissions >137 lb/day	S	Mitigation Measure AQ-1: Implement Standard Measures and Best Available Mitigation Measures to Reduce Emissions Levels.	SU

Notes:

[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.

[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.

[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.

[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.

[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact AQ-2: Long-Term Emissions of Criteria Air Pollutants and Precursors During Project Operation	N-A,	Long-term	–	LTS	NA	LTS
	CP1,	Long-term	Increase of an average of 158 one-way daily trips	LTS	No mitigation needed, thus none proposed.	LTS
	CP2	Long-term	Increase of an average of 238 one-way daily trips	LTS	No mitigation needed; thus, none proposed.	LTS
	CP3	Long-term	Increase of an average of 364 one-way daily trips	LTS	No mitigation needed; thus, none proposed.	LTS
	CP4	Long-term	Increase of an average of 658 one-way daily trips	LTS	No mitigation needed; thus, none proposed.	LTS
	CP4A	Long-term	Increase of an average of 460 one-way daily trips	LTS	No mitigation needed; thus, none proposed.	LTS
	CP5	Long-term	Increase of an average of 311 one-way daily trips	LTS	No mitigation needed; thus, none proposed.	LTS
Impact AQ-3: Exposure of Sensitive Receptors to Substantial Pollutant Concentrations	N-A	NA	–	NI	NA	NI
	CP1–CP5	Short-term and long-term	Exposure to CO, PM_{10}, $PM_{2.5}$, diesel PM	LTS	No mitigation needed; thus, none proposed.	LTS
Impact AQ-4: Exposure of Sensitive Receptors to Odor Emissions	N-A	NA	–	NI	NA	NI
	CP1–CP5	Short-term and long-term	–	LTS	No mitigation needed; thus, none proposed.	LTS

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact AQ-5: Short-Term Emissions of Criteria Air Pollutants and Precursors Below Shasta Dam During Project Construction	N-A,	NA	–	NI	NA	NI
	CP1–CP3	Short-term	–	NI	No mitigation needed; thus, none proposed.	NI
	CP4–CP5	Short-term	Would add an additional 1 lb/day of ROG, 16 lb/day of NO_X, & 1 lb/day of PM_{10} to construction	LTS	No mitigation needed; thus, none proposed.	LTS
Impact AQ-6: Generation of Greenhouse Gases	N-A	NA	–	LTS	NA	LTS
	CP1–CP5	Short-term	Emission of 15,100 to 83,400 metric tons CO_2e	LTS	No mitigation needed; thus, none proposed.	LTS
Hydrology, Hydraulics, and Water Management						
Impact H&H-1: Change in Frequency of Flows Above 100,000 cfs on the Sacramento River Below Bend Bridge	N-A	NA	–	NI	NA	NI
	CP1–CP5	Long-term	–	B	No mitigation needed; thus, none proposed.	B
Impact H&H-2: Place Housing or Other Structures Within a 100-Year Flood Hazard Area as Mapped on a Federal Flood Hazard Boundary or Flood Insurance Rate Map or Other Flood Hazard Delineation Map	N-A	NA	–	NI	NA	NI
	CP1–CP5	NA	–	NI	No mitigation needed; thus, none proposed.	NI

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact H&H-3: Place Within a 100-Year Flood Hazard Area Structures That Would Impede or Redirect Flood Flows	N-A	NA	–	NI	NA	NI
	CP1–CP5	NA	–	NI	No mitigation needed; thus, none proposed.	NI
Impact H&H-4: Change in Water Levels in the Old River near Tracy Road Bridge	N-A	Long-term	Lower water levels	LTS	NA	LTS
	CP1–CP5	Long-term	–	LTS	No mitigation needed; thus, none proposed.	LTS
H&H-5: Change in Water Levels in the Grant Line Canal near the Grant Line Canal Barrier	N-A	Long-term	Lower water levels	LTS	NA	LTS
	CP1–CP5	Long-term	–	LTS	No mitigation needed; thus, none proposed.	LTS
Impact H&H-6: Change in Water Levels in the Middle River near the Howard Road Bridge	N-A	Long-term	Lower water levels	LTS	NA	LTS
	CP1–CP5	Long-term	–	LTS	No mitigation needed; thus, none proposed.	LTS
Impact H&H-7: Change in X2 Position	N-A	NA	–	NI	NA	NI
	CP1 & CP4	NA	–	NI	No mitigation needed; thus, none proposed.	NI
	CP2, CP3, CP4A, & CP5	Long-term	–	LTS	No mitigation needed; thus, none proposed.	LTS
Impact H&H-8: Change in Recurrence of Delta Excess Conditions	N-A	Long-term	Reduced frequency	LTS	NA	LTS
	CP1–CP5	Long-term	–	LTS	No mitigation needed; thus, none proposed.	LTS

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact H&H-9: Change in Deliveries to North-of-Delta CVP Water Service Contractors and Refuges	N-A	Long-term	Reduced frequency	PS	NA	PS
	CP1–CP5	Long-term	–	LTS	No mitigation needed; thus, none proposed.	LTS
Impact H&H-10: Change in Deliveries to South-of-Delta CVP Water Service Contractors and Refuges	N-A	Long-term	Reduced frequency	PS	NA	PS
	CP1, CP3–CP5	Long-term	–	B	No mitigation needed; thus, none proposed.	B
	CP2	Long-term	–	LTS	No mitigation needed; thus, none proposed.	LTS
Impact H&H-11: Change in Deliveries to SWP Table A, Contractors	N-A	Long-term	Reduced frequency	B	NA	B
	CP1–CP5	Long-term	–	LTS	No mitigation needed; thus, none proposed.	LTS
Impact H&H-12: Change in Groundwater	N-A	NA	–	LTS	NA	LTS
	CP1–CP5	Short-term and long-term	Increased groundwater levels	B	No mitigation needed; thus, none proposed.	B
Impact H&H-13: Change in Groundwater Quality	N-A	Short-term and long-term	–	LTS	NA	LTS
	CP1–CP5	Short-term and long-term	–	LTS	No mitigation needed; thus, none proposed.	LTS

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Water Quality						
Impact WQ-1: Temporary Construction-Related Sediment Effects on Shasta Lake and Its Tributaries that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses	N-A	NA	–	NI	NA	NI
	CP1	Short-term	Short-term changes in the amount of exposed area that would be subject to erosion	PS	Mitigation Measure WQ-1: Develop and Implement a Comprehensive Multi-scale Sediment Reduction and Water Quality Improvement Program Within Watersheds Tributary to the Primary Study Area.	LTS
	CP2	Short-term	Similar to CP1, but greater area and longer duration	PS	Mitigation Measure WQ-1: Develop and Implement a Comprehensive Multi-scale Sediment Reduction and Water Quality Improvement Program Within Watersheds Tributary to the Primary Study Area.	LTS
	CP3–CP5	Short-term	Similar to CP1 and CP2, but greater area and longer duration	PS	Mitigation Measure WQ-1: Develop and Implement a Comprehensive Multi-scale Sediment Reduction and Water Quality Improvement Program Within Watersheds Tributary to the Primary Study Area.	LTS

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact WQ-2: Temporary Construction-Related Temperature Effects on Shasta Lake and Its Tributaries that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses	N-A	NA	–	NI	NA	NI
	CP1	Short-term	Some areas potentially subject to surface disturbance, including jurisdictional waters	LTS	No mitigation needed; thus, none proposed.	LTS
	CP2	Short-term	Similar to CP1, but greater area and longer duration	LTS	No mitigation needed; thus, none proposed.	LTS
	CP3–CP5	Short-term	Similar to CP1 and CP2, but greater area and longer duration	LTS	No mitigation needed; thus, none proposed.	LTS
Impact WQ-3: Temporary Construction-Related Metal Effects on Shasta Lake and Its Tributaries that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses	N-A	NA	–	NI	NA	NI
	CP1–CP5	Short-term	–	LTS	No mitigation needed; thus, none proposed.	LTS
Impact WQ-4: Long-Term Sediment Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in Shasta Lake or Its Tributaries	N-A	NA	–	NI	NA	NI
	CP1–CP5	Long-term	–	PS	Mitigation Measure WQ-4: Implement Mitigation Measure WQ-1 (CP1): Develop and Implement a Comprehensive Multi-scale Sediment Reduction and Water Quality Improvement Program Within Watersheds Tributary to the Primary Study Area.	LTS

Notes:

[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.

[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.

[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.

[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.

[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact WQ-5: Long-Term Temperature Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in Shasta Lake or Its Tributaries	N-A	NA	–	NI	NA	NI
	CP1	Long-term	5 percent increase in the end-of-month storage on an annual basis compared to No-Action Alternative	LTS	No mitigation needed; thus, none proposed.	LTS
	CP2	Long-term	10 percent increase in the end-of-month storage on an annual basis compared to No-Action Alternative	LTS	No mitigation needed; thus, none proposed.	LTS
	CP3	Long-term	14 percent increase in the end-of-month storage on an annual basis compared to No-Action Alternative	LTS	No mitigation needed; thus, none proposed.	LTS
	CP4	Long-term	17 percent increase in the end-of-month storage on an annual basis compared to No-Action Alternative	LTS	No mitigation needed; thus, none proposed.	LTS
	CP4A	Long-term	16 percent increase in the end-of-month storage on an annual basis compared to No-Action Alternative	LTS	No mitigation needed; thus, none proposed.	LTS
	CP5	Long-term	13 percent increase in the end-of-month storage on an annual basis compared to No-Action Alternative	LTS	No mitigation needed; thus, none proposed.	LTS
WQ-6: Long-Term Metals Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in Shasta Lake or Its Tributaries	N-A	NA	–	LTS	NA	LTS
	CP1–CP5	Long-term	–	PS	Mitigation Measure WQ-6: Prepare and Implement a Site-Specific Remediation Plan for Historic Mine Features Subject to Inundation in the Vicinity of the Bully Hill and Rising Star Mines.	LTS

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact WQ-7: Temporary Construction-Related Sediment Effects on the Upper Sacramento River that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses	N-A	NA	–	NI	NA	NI
	CP1–CP3	Temporary	–	PS	Mitigation Measure WQ-7 (CP1–CP3): Implement Mitigation Measure WQ-1 (CP1): Develop and Implement a Comprehensive Multi-scale Sediment Reduction and Water Quality Improvement Program Within Watersheds Tributary to the Primary Study Area.	LTS
	CP4 & CP4A	Temporary	Similar to CP1–CP3, but greater	PS	Mitigation Measure WQ-7 (CP4): Implement Mitigation Measure WQ-1 (CP1): Develop and Implement a Comprehensive Multi-scale Sediment Reduction and Water Quality Improvement Program Within Watersheds Tributary to the Primary Study Area.	LTS
	CP5	Temporary	Similar to CP4, but greater	PS	Mitigation Measure WQ-7 (CP5): Implement Mitigation Measure WQ-1 (CP1): Develop and Implement a Comprehensive Multi-scale Sediment Reduction and Water Quality Improvement Program Within Watersheds Tributary to the Primary Study Area.	LTS

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact WQ-8: Temporary Construction-Related Temperature Effects on the Upper Sacramento River that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses	N-A	NA	–	NI	NA	NI
	CP1–CP5	Temporary	–	LTS	No mitigation needed; thus, none proposed.	LTS
Impact WQ-9: Temporary Construction-Related Metal Effects on the Upper Sacramento River that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses	N-A	NA	–	NI	NA	NI
	CP1–CP5	Temporary	–	LTS	No mitigation needed; thus, none proposed.	LTS
Impact WQ-10: Long-Term Sediment Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Upper Sacramento River	N-A	NA	–	LTS	NA	LTS
	CP1–CP5	Long-term	–	LTS	No mitigation needed; thus, none proposed.	LTS

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact WQ-11: Long-Term Temperature Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Upper Sacramento River	N-A	NA	–	LTS	NA	LTS
	CP1	Long-term	Reduce temperature exceedences at Bend Bridge by 4 percent under existing conditions and 5 percent under future conditions	B	No mitigation needed; thus, none proposed.	B
	CP2	Long-term	Reduce temperature exceedences at Bend Bridge by 7 percent under existing conditions and future conditions	B	No mitigation needed; thus, none proposed.	B
	CP3	Long-term	Reduce temperature exceedences at Bend Bridge by 11 percent under existing conditions and 10 percent under future conditions	B	No mitigation needed; thus, none proposed.	B
	CP4	Long-term	Reduce temperature exceedences at Bend Bridge by 13 percent under existing conditions and future conditions	B	No mitigation needed; thus, none proposed.	B
	CP4A	Long-term	Reduce temperature exceedences at Bend Bridge by 11 percent under existing conditions and future conditions	B	No mitigation needed; thus, none proposed.	B
	CP5	Long-term	Reduce temperature exceedences at Bend Bridge by 10 percent under existing conditions and future conditions	B	No mitigation needed; thus, none proposed.	B
Impact WQ-12: Long-Term Metals Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Upper Sacramento River	N-A	NA	–	LTS	NA	LTS
	CP1–CP5	Long-term	–	PS	Mitigation Measure WQ-12: Implement Mitigation Measure WQ-6 (CP1): Prepare and Implement a Site-Specific Remediation Plan for Historic Mine Features Subject to Inundation in the Vicinity of the Bully Hill and Rising Star Mines	LTS

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact WQ-13: Temporary Construction-Related Sediment Effects on the Extended Study Area that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses	N-A	NA	–	NI	NA	NI
	CP1–CP5	Temporary	–	LTS	No mitigation needed; thus, none proposed.	LTS
Impact WQ-14: Temporary Construction-Related Temperature Effects on the Extended Study Area that Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses	N-A	NA	–	NI	NA	NI
	CP1–CP5	Temporary	–	LTS	No mitigation needed; thus, none proposed.	LTS
Impact WQ-15: Temporary Construction-Related Metal Effects on the Extended Study Area that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses	N-A	NA	–	NI	NA	NI
	CP1–CP5	Temporary	–	LTS	No mitigation needed; thus, none proposed.	LTS
Impact WQ-16: Long-Term Sediment Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Extended Study Area	N-A	NA	–	LTS	NA	LTS
	CP1–CP5	Long-term	–	LTS	No mitigation needed; thus, none proposed.	LTS

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact WQ-17: Long-Term Temperature Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Extended Study Area	N-A	NA	–	LTS	NA	LTS
	CP1–CP5	Long-term	–	LTS	No mitigation needed; thus, none proposed.	LTS
Impact WQ-18: Long-Term Metals Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Extended Study Area	N-A	NA	–	LTS	NA	LTS
	CP1–CP5	Long-term	–	PS	Mitigation Measure WQ-18: Implement Mitigation Measure WQ-6 (CP1): Prepare and Implement a Site-Specific Remediation Plan for Historic Mine Features Subject to Inundation in the Vicinity of the Bully Hill and Rising Star Mines	LTS
Impact WQ-19a: Delta Salinity on the Sacramento River at Collinsville	N-A	NA	–	LTS	NA	LTS
	CP1–CP5	Long-term	No additional violations of water quality standards	LTS	No mitigation needed; thus, none proposed.	LTS
Impact WQ-19b: Delta Salinity on the San Joaquin River at Jersey Point	N-A	NA	–	LTS	NA	LTS
	CP1–CP5	Long-term	No additional violations of water quality standards	LTS	No mitigation needed; thus, none proposed.	LTS
Impact WQ-19c: Delta Salinity on the Sacramento River at Emmaton	N-A	NA	–	LTS	NA	LTS
	CP1–CP5	Long-term	No additional violations of water quality standards	LTS	No mitigation needed; thus, none proposed.	LTS

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact WQ-19d: Delta Salinity on the Old River at Rock Slough	N-A	NA	–	LTS	NA	LTS
	CP1–CP5	Long-term	No additional violations of water quality standards	LTS	No mitigation needed; thus, none proposed.	LTS
Impact WQ-19e: Delta Water Quality on the Delta-Mendota Canal at Jones Pumping Plant	N-A	NA	–	LTS	NA	LTS
	CP1–CP5	Long-term	No additional violations of water quality standards	LTS	No mitigation needed; thus, none proposed.	LTS
Impact WQ-19f: Delta Water Quality on the West Canal at the Mouth of the Clifton Court Forebay	N-A	NA	–	LTS	NA	LTS
	CP1–CP5	Long-term	No additional violations of water quality standards	LTS	No mitigation needed; thus, none proposed.	LTS
Impact WQ-19g: Delta Salinity on the San Joaquin River at Vernalis	N-A	NA	–	LTS	NA	LTS
	CP1–CP5	Long-term	No additional violations of water quality standards	LTS	No mitigation needed; thus, none proposed.	LTS
Impact WQ-19h: Delta Salinity on the San Joaquin River at Brandt Bridge	N-A	NA	–	LTS	NA	LTS
	CP1–CP5	Long-term	No additional violations of water quality standards	LTS	No mitigation needed; thus, none proposed.	LTS
Impact WQ-19i: Delta Salinity on the Old River near the Middle River	N-A	NA	–	LTS	NA	LTS
	CP1–CP5	Long-term	No additional violations of water quality standards	LTS	No mitigation needed; thus, none proposed.	LTS
Impact WQ-19j: Delta Salinity on the Old River at Tracy Road Bridge	N-A	NA	–	LTS	NA	LTS
	CP1–CP5	Long-term	No additional violations of water quality standards	LTS	No mitigation needed; thus, none proposed.	LTS

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact WQ-20: X2 Position	N-A	NA	–	PS	NA	SU
	CP1–CP5	Long-term	No increase in number of months in which X2 is out of compliance in extended study area (Delta)	LTS	No mitigation needed; thus, none proposed.	LTS
Noise and Vibration						
Impact Noise-1: Exposure of Sensitive Receptors in the Primary Study Area to Project-Generated Construction Noise	N-A	Long-term	–	LTS	NA	LTS
	CP1–CP3	Short-term	On-site heavy duty construction equipment at other project sites – exterior noise levels at noise-sensitive receptors located within 75 – 7,000 feet of construction activity could exceed applicable standards	S	Mitigation Measure Noise-1: Implement Measures to Prevent Exposure of Sensitive Receptors to Temporary Construction Noise at Project Construction Sites.	LTS
	CP4–CP5	Short-term	Similar to CP1–CP3, but greater noise related to gravel augmentation and habitat restoration along the upper Sacramento River	S	Mitigation Measure Noise-1: Implement Measures to Prevent Exposure of Sensitive Receptors to Temporary Construction Noise at Project Construction Sites.	LTS
Impact Noise-2: Exposure of Sensitive Receptors in the Primary Study Area to Project-Generated Vibration During Construction	N-A	Long-term	–	LTS	NA	LTS
	CP1–CP5	Short-term	–	LTS	No mitigation needed; thus, none proposed.	LTS
Impact Noise-3: Exposure of Sensitive Receptors in the Primary Study Area to Project-Generated Mobile Source Noise During Operations	N-A	Long-term	–	LTS	NA	LTS
	CP1–CP5	Short-term and long-term	–	LTS	No mitigation needed; thus, none proposed.	LTS

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Hazards and Hazardous Materials and Waste						
Impact Haz-1: Wildland Fire Risk (Shasta Lake and Vicinity and Upper Sacramento River)	N-A	NA	–	NI	NA	NI
	CP1	Short-term	Increased risk of ignition during construction	PS	Mitigation Measure Haz-1: Coordinate and Assist Public Services Agencies to Reduce Fire Hazards.	LTS
	CP2	Short-term	Similar to CP1, but greater and longer construction duration	PS	Mitigation Measure Haz-1: Coordinate and Assist Public Services Agencies to Reduce Fire Hazards.	LTS
	CP3	Short-term	Similar to CP1 & CP2, but greater and longer construction duration	PS	Mitigation Measure Haz-1: Coordinate and Assist Public Services Agencies to Reduce Fire Hazards.	LTS
	CP4–CP5	Short-term	Similar to CP3, but greater and longer construction duration	PS	Mitigation Measure Haz-1: Coordinate and Assist Public Services Agencies to Reduce Fire Hazards.	LTS
Impact Haz-2: Release of Potentially Hazardous Materials or Hazardous Waste (Shasta Lake and Vicinity and Upper Sacramento River)	N-A	NA	–	NI	NA	NI
	CP1	Short-term	Risk of release of hazardous materials during construction	PS	Mitigation Measure Haz-2: Reduce Potential for Release of Hazardous Materials and Waste.	LTS
	CP2	Short-term	Similar to CP1, but greater and longer construction duration	PS	Mitigation Measure Haz-2: Reduce Potential for Release of Hazardous Materials and Waste.	LTS
	CP3	Short-term	Similar to CP1 & CP2, but greater and longer construction duration	PS	Mitigation Measure Haz-2: Reduce Potential for Release of Hazardous Materials and Waste.	LTS
	CP4–CP5	Short-term	Similar to CP3, but greater construction	PS	Mitigation Measure Haz-2: Reduce Potential for Release of Hazardous Materials and Waste.	LTS

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Haz-3: Exposure of Workers to Hazardous Materials (Shasta Lake and Vicinity and Upper Sacramento River)	N-A	NA	–	NI	NA	NI
	CP1	Short-term	Risk of exposure to hazardous materials during construction	LTS	No mitigation needed; thus, none proposed.	LTS
	CP2	Short-term	Similar to CP1, but greater and longer duration	LTS	No mitigation needed; thus, none proposed.	LTS
	CP3	Short-term	Similar to CP1 & CP2, but greater and longer duration construction	LTS	No mitigation needed; thus, none proposed.	LTS
	CP4–CP5	Short-term	Similar to CP3, but greater construction	LTS	No mitigation needed; thus, none proposed.	LTS
Impact Haz-4: Exposure of Sensitive Receptors to Hazardous Materials (Shasta Lake and Vicinity and Upper Sacramento River)	N-A	NA	–	NI	NA	NI
	CP1	Short-term	Risk of exposure to hazardous materials during construction	PS	Mitigation Measure Haz-4: Reduce Potential for Exposure of Sensitive Receptors to Hazardous Materials or Waste.	LTS
	CP2	Short-term	Similar to CP1, but greater and longer construction duration	PS	Mitigation Measure Haz-4: Reduce Potential for Exposure of Sensitive Receptors to Hazardous Materials or Waste.	LTS
	CP3	Short-term	Similar to CP1 & CP2, but greater and longer construction duration	PS	Mitigation Measure Haz-4: Reduce Potential for Exposure of Sensitive Receptors to Hazardous Materials or Waste.	LTS
	CP4–CP5	Short-term	Similar to CP3, but greater construction	PS	Mitigation Measure Haz-4: Reduce Potential for Exposure of Sensitive Receptors to Hazardous Materials or Waste.	LTS

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Haz-5: Wildland Fire Risk (Lower Sacramento River, Delta, CVP/SWP Service Areas)	N-A	NA	–	NI	NA	NI
	CP1–CP5	Short-term	–	LTS	No mitigation needed; thus, none proposed.	LTS
Impact Haz-6: Release of Potentially Hazardous Materials or Hazardous Waste (Lower Sacramento River, Delta, CVP/SWP Service Areas)	N-A	NA	–	NI	NA	NI
	CP1–CP5	Short-term	–	LTS	No mitigation needed; thus, none proposed.	LTS
Impact Haz-7: Exposure of Workers to Hazardous Materials (Lower Sacramento River, Delta, CVP/SWP Service Areas)	N-A	NA	–	NI	NA	NI
	CP1–CP5	Short-term	–	LTS	No mitigation needed; thus, none proposed.	LTS
Impact Haz-8: Exposure of Sensitive Receptors to Hazardous Materials (Lower Sacramento River, Delta, CVP/SWP Service Areas)	N-A	NA	–	NI	NA	NI
	CP1–CP5	Short-term	–	LTS	No mitigation needed; thus, none proposed.	LTS
Agriculture and Important Farmlands						
Impact Ag-1: Direct and Indirect Conversion of Important Farmland to Nonagricultural Uses and Cancellation of Williamson Act Contracts in the Vicinity of Shasta Lake	N-A	Permanent	–	PS	NA	SU
	CP1–CP5	Permanent	–	NI	No mitigation needed; thus, none proposed.	NI

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Ag-2: Direct and Indirect Conversion of Forest Land to Nonforest Uses in the Vicinity of Shasta Lake	N-A	NA	NA	NI	NA	NI
	CP1	Permanent	Permanent conversion of forest land by inundation and infrastructure relocation	S	No feasible mitigation is available to reduce impact.	SU
	CP2	Permanent	Similar to CP1, but greater.	S	No feasible mitigation is available to reduce impact.	SU
	CP3–CP5	Permanent	Similar to CP1 and CP2, but greater.	S	No feasible mitigation is available to reduce impact.	SU
Impact Ag-3: Direct and Indirect Conversion of Important Farmland to Nonagricultural Uses and Cancellation of Williamson Act Contracts Along the Upper Sacramento River	N-A	Permanent	–	PS	NA	SU
	CP1 & CP4	Permanent	Inundation of lands or soil saturation due to increased flows.	LTS	No mitigation needed; thus, none proposed.	LTS
	CP2 & CP4A	Permanent	Similar to CP1, but greater	LTS	No mitigation needed; thus, none proposed.	LTS
	CP3	Permanent	Similar to CP1 & CP2, but greater	LTS	No mitigation needed; thus, none proposed.	LTS
	CP5	Permanent	Similar to CP1, CP2, & CP3 but greater	LTS	No mitigation needed; thus, none proposed.	LTS
Impact Ag-4: Direct and Indirect Conversion of Forest Land to Nonforest Uses Along the Upper Sacramento River	N-A	Permanent	–	LTS	NA	LTS
	CP1	Permanent	Altered dynamics and structure of forests in the riparian corridor along the upper Sacramento River due to increased flows	LTS	No mitigation needed; thus, none proposed.	LTS
	CP2	Permanent	Similar to CP1, but greater	LTS	No mitigation needed; thus, none proposed.	LTS
	CP3–CP5	Permanent	Similar to CP1 & CP2, but greater	LTS	No mitigation needed; thus, none proposed.	LTS

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Ag-5: Direct and Indirect Conversion of Important Farmland to Nonagricultural Uses and Cancellation of Williamson Act Contracts in the Extended Study Area	N-A	Permanent	–	PS	NA	SU
	CP1–CP5	Permanent	Inundation of lands or soil saturation due to increased flows.	LTS	No mitigation needed; thus, none proposed.	LTS
Impact Ag-6: Direct and Indirect Conversion of Forest Land to Nonforest Uses in the Extended Study Area	N-A	Permanent	–	LTS	NA	LTS
	CP1–CP5	Permanent	Altered dynamics and structure of forests in the riparian corridor in the extended study area due to increased flows	LTS	No mitigation needed; thus, none proposed.	LTS
Fisheries and Aquatic Ecosystems						
Impact Aqua-1: Effects on Nearshore, Warm-Water Habitat in Shasta Lake from Project Operations	N-A	Permanent	–	LTS	NA	LTS
	CP1–CP5	Permanent	–	LTS	No mitigation needed; thus, none proposed.	LTS
Impact Aqua-2: Effects on Nearshore, Warm-Water Habitat in Shasta Lake from Project Construction	N-A	NA	–	NI	NA	NI
	CP1–CP5	Short-term	–	LTS	No mitigation needed; thus, none proposed.	LTS
Impact Aqua-3: Effects on Cold-Water Habitat in Shasta Lake	N-A	Long-term	–	PS	NA	PS
	CP1–CP5	Long-term	–	B	No mitigation needed; thus, none proposed.	B

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Aqua-4: Effects on Special-Status Aquatic Mollusks	N-A	Long-term	–	LTS	NA	LTS
	CP1–CP5	Permanent	–	PS	Mitigation Measure Aqua-4: Implement Mitigation Measure Geo-2: Replace Lost Ecological Functions of Aquatic Habitats by Restoring Existing Degraded Aquatic Habitats in the Vicinity of the Impact.	LTS
Impact Aqua-5: Effects on Special-Status Fish Species	N-A	–	–	LTS	NA	LTS
	CP1–CP5	–	–	LTS	No mitigation needed; thus, none proposed.	LTS
Impact Aqua-6: Creation or Removal of Barriers to Fish Between Tributaries and Shasta Lake	N-A	NA	–	NI	NA	NI
	CP1–CP5	Permanent	–	LTS	No mitigation needed; thus, none proposed.	LTS

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Aqua-7: Effects on Spawning and Rearing Habitat of Adfluvial Salmonids in Low-Gradient Tributaries to Shasta Lake	N-A	NA	–	NI	NA	NI
	CP1	Permanent	5.4 miles of low-gradient reaches	PS	Mitigation Measure Aqua-7: Implement Mitigation Measure Aqua-4: Replace Lost Ecological Functions of Aquatic Habitats by Restoring Existing Degraded Aquatic Habitats in the Vicinity of the Impact.	LTS
	CP2	Permanent	7.4 miles of low-gradient reaches	PS	Mitigation Measure Aqua-7: Implement Mitigation Measure Aqua-4: Replace Lost Ecological Functions of Aquatic Habitats by Restoring Existing Degraded Aquatic Habitats in the Vicinity of the Impact.	LTS
	CP3–CP5	Permanent	11 miles of low-gradient reaches	PS	Mitigation Measure Aqua-7: Implement Mitigation Measure Aqua-4: Replace Lost Ecological Functions of Aquatic Habitats by Restoring Existing Degraded Aquatic Habitats in the Vicinity of the Impact.	LTS
Impact Aqua-8: Effects on Aquatic Connectivity in Non-Fish-Bearing Tributaries to Shasta Lake	N-A	NA	–	NI	NA	NI
	CP1	Permanent	12.6 miles of non-fish-bearing tributary habitat	LTS	No mitigation needed; thus, none proposed.	LTS
	CP2	Permanent	17.3 miles of non-fish-bearing tributary habitat	LTS	No mitigation needed; thus, none proposed.	LTS
	CP3–CP5	Permanent	24.0 miles of non-fish-bearing tributary habitat	LTS	No mitigation needed; thus, none proposed.	LTS

Notes:

[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.

[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.

[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.

[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.

[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Aqua-9: Effects on Water Quality at Livingston Stone Hatchery	N-A	NA	–	NI	NA	NI
	CP1–CP5	NA	–	NI	No mitigation needed; thus, none proposed.	NI
Impact Aqua-10: Loss or Degradation of Aquatic Habitat in the Upper Sacramento River During Construction Activities	N-A	NA	–	NI	NA	NI
	CP1–CP5	Short-term and long-term	–	LTS	No mitigation needed; thus, none proposed.	LTS
Impact Aqua-11: Release and Exposure of Contaminants in the Upper Sacramento River During Construction Activities	N-A	NA	–	NI	NA	NI
	CP1–CP5	Short-term and long-term	–	LTS	No mitigation needed; thus, none proposed.	LTS
Impact Aqua-12: Changes in Flow and Water Temperature in the Upper Sacramento River Resulting from Project Operation—Chinook Salmon and Steelhead	N-A	NA	–	PS	NA	PS
	CP1	Long-term	Improved flow and water temperature conditions in the upper Sacramento River	LTS	No mitigation needed; thus, none proposed.	LTS
	CP2	Long-term	Similar to CP1, but greater benefits	B	No mitigation needed; thus, none proposed.	B
	CP3 & CP5	Long-term	Similar to CP1 and CP2, but greater benefits	B	No mitigation needed; thus, none proposed.	B
	CP4 & CP4A	Long-term	Similar to CP1- CP3 & CP5, but greater benefits	B	No mitigation needed; thus, none proposed.	B

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Aqua-13: Changes in Flow and Water Temperature in the Upper Sacramento River Resulting from Project Operation—Steelhead, Green Sturgeon, Sacramento Splittail, American Shad, and Striped Bass	N-A	NA	–	PS	NA	PS
	CP1	Long-term	Slightly improved flow and water temperature conditions in the upper Sacramento River	LTS	No mitigation needed; thus, none proposed.	LTS
	CP2	Long-term	Similar to CP1, but greater in magnitude	LTS	No mitigation needed; thus, none proposed.	LTS
	CP3 & CP5	Long-term	Similar to CP1 & CP2, but greater in magnitude	LTS	No mitigation needed; thus, none proposed.	LTS
	CP4 & CP4A	Long-term	Similar to CP1–CP3 & CP5, but greater in magnitude	B	No mitigation needed; thus, none proposed.	B
Impact Aqua-14: Reduction in Ecologically Important Geomorphic Processes in the Upper Sacramento River Resulting from Reduced Frequency and Magnitude of Intermediate to High Flows	N-A	NA	–	NI	NA	NI
	CP1–CP5	Long-term	–	PS	Mitigation Measure Aqua-14: Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities.	LTS

Notes:
1 Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
2 NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
3 NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
4 LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
5 NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Aqua-15: Changes in Flow and Water Temperatures in the Lower Sacramento River and Tributaries and Trinity River Resulting from Project Operation – Fish Species of Primary Management Concern	N-A	NA	–	NI	NA	NI
	CP1–CP5	Long-term	–	PS	Mitigation Measure Aqua-15: Maintain Flows in the Feather River, American River, and Trinity River Consistent with Existing Regulatory and Operational Requirements and Agreements.	LTS
Impact Aqua-16: Reduction in Ecologically Important Geomorphic Processes in the Lower Sacramento River Resulting from Reduced Frequency and Magnitude of Intermediate to High Flows	N-A	NA	–	NI	NA	NI
	CP1–CP5	Long-term	–	PS	Mitigation Measure Aqua-16: Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities.	LTS
Impact Aqua-17: Effects to Delta Fishery Habitat Resulting from Changes to Delta Outflow	N-A	NA	–	NI	NA	NI
	CP1–CP5	Long-term	–	LTS	No mitigation needed; thus, none proposed.	LTS
Impact Aqua-18: Effects to Delta Fisheries Resulting from Changes to Delta Inflow	N-A	NA	–	NI	NA	NI
	CP1–CP5	Long-term	–	LTS	No mitigation needed; thus, none proposed.	LTS

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Aqua-19: Effects to Delta Fisheries Resulting from Changes in Sacramento River Inflow	N-A	NA	–	NI	NA	NI
	CP1–CP5	Long-term	–	LTS	No mitigation needed; thus, none proposed.	LTS
Impact Aqua-20: Effects to Delta Fisheries Resulting from Changes in San Joaquin River Flow at Vernalis	N-A	NA	–	NI	NA	NI
	CP1–CP5	NA	–	NI	No mitigation needed; thus, none proposed.	NI
Impact Aqua-21: Reduction in Low-Salinity Habitat Conditions Resulting from an Upstream Shift in X2 Location	N-A	NA	–	NI	NA	NI
	CP1–CP5	Long-term	–	LTS	No mitigation needed; thus, none proposed.	LTS
Impact Aqua-22: Increase in Mortality of Species of Primary Management Concern as a Result of Increased Reverse Flows in Old and Middle Rivers	N-A	NA	NA	NI	NA	NI
	CP1–CP5	Long-term	–	LTS	No mitigation needed; thus, none proposed.	LTS
Impact Aqua-23: Increase in the Risk of Entrainment or Salvage of Species of Primary Management Concern at CVP and SWP Export Facilities Due to Changes in CVP and SWP Exports	N-A	NA	–	NI	NA	NI
	CP1–CP5	Long-term	–	PS	None proposed because operations will be guided by RPAs established by NMFS and USFWS BOs to reduce any impacts to listed fish species, and thus reduce impacts to non-listed fish species	LTS

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Aqua-24: Impacts on Aquatic Habitats and Fish Populations in the CVP and SWP Service Areas Resulting from Modifications to Existing Flow Regimes	N-A	NA	–	NI	NA	NI
	CP1–CP5	Long-term	–	LTS	No mitigation needed; thus, none proposed.	LTS
Botanical Resources and Wetlands						
Impact Bot-1: Loss of Federally or State Listed Plant Species	N-A	NA	–	NI	NA	NI
	CP1–CP5	NA	–	NI	No mitigation needed; thus, none proposed.	NI
Impact Bot-2: Loss of MSCS Covered Species	N-A	Permanent	–	NI	NA	NI
	CP1	Permanent	Portions of MSCS plant populations could be inundated	S	Mitigation Measure Bot-2: Acquire and Preserve Mitigation Lands; Avoid Populations; Relocate MSCS Plants; and Revegetate Affected Areas.	SU
	CP2	Permanent	Greater than CP1	S	Mitigation Measure Bot-2: Acquire and Preserve Mitigation Lands; Avoid Populations; Relocate MSCS Plants; and Revegetate Affected Areas.	SU
	CP3–CP5	Permanent	Greater than CP1 & CP2	S	Mitigation Measure Bot-2: Acquire and Preserve Mitigation Lands; Avoid Populations; Relocate MSCS Plants; and Revegetate Affected Areas.	SU

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Bot-3: Loss of USFS Sensitive, BLM Sensitive, or CRPR Species	N-A	Permanent	–	NI	NA	NI
	CP1	Permanent	Portions of USFS sensitive, BLM sensitive, and CRPR species plant populations could be inundated	PS	Mitigation Measure Bot-3: Acquire and Preserve Mitigation Lands; Avoid Populations; Relocate USFS Sensitive, BLM Sensitive, and CRPR Plants and Revegetate Affected Areas.	SU
	CP2	Permanent	Greater than CP1	PS	Mitigation Measure Bot-3: Acquire and Preserve Mitigation Lands; Avoid Populations; Relocate USFS Sensitive, BLM Sensitive, and CRPR Plants and Revegetate Affected Areas.	SU
	CP3–CP5	Permanent	Greater than CP1 & CP2	PS	Mitigation Measure Bot-3: Acquire and Preserve Mitigation Lands; Avoid Populations; Relocate USFS Sensitive, BLM Sensitive, and CRPR Plants and Revegetate Affected Areas.	SU
Impact Bot-4: Loss of Jurisdictional Waters	N-A	Permanent	–	NI	NA	NI
	CP1	Permanent	Loss of jurisdictional waters caused by flooding the impoundment area and discharge of fill associated with the relocation of facilities and dam construction	S	Mitigation Measure Bot-4: Mitigate Loss of Jurisdictional Waters.	SU
	CP2	Permanent	Greater than CP1	S	Mitigation Measure Bot-4: Mitigate Loss of Jurisdictional Waters.	SU
	CP3–CP5	Permanent	Greater than CP1 & CP2	S	Mitigation Measure Bot-4: Mitigate Loss of Jurisdictional Waters.	SU

Notes:

[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.

[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.

[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.

[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.

[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Bot-5: Loss of General Vegetation Habitats	N-A	Permanent	–	NI	NA	NI
	CP1	Permanent	Loss of general vegetation habitats because of inundation, vegetation removal, or construction activities	PS	Mitigation Measure Bot-5: Acquire and Preserve Mitigation Lands for Loss of General Vegetation Habitats.	SU
	CP2	Permanent	Greater than CP1	PS	Mitigation Measure Bot-5: Acquire and Preserve Mitigation Lands for Loss of General Vegetation Habitats.	SU
	CP3–CP5	Permanent	Greater than CP1 & CP2	PS	Mitigation Measure Bot-5: Acquire and Preserve Mitigation Lands for Loss of General Vegetation Habitats.	SU
Impact Bot-6: Spread of Noxious and Invasive Weeds	N-A	NA	–	NI	NA	NI
	CP1	Long-term and/or permanent	Spread of noxious and invasive weeds as a result of ground-disturbing activities during construction and an increased number of vectors	PS	Mitigation Measure Bot-6: Develop and Implement a Weed Management Plan In Conjunction with Stakeholders.	LTS
	CP2	Long-term and/or permanent	Greater than CP1	PS	Mitigation Measure Bot-6: Develop and Implement a Weed Management Plan In Conjunction with Stakeholders.	LTS
	CP3–CP5	Long-term and/or permanent	Greater than CP1 & CP2	PS	Mitigation Measure Bot-6: Develop and Implement a Weed Management Plan In Conjunction with Stakeholders.	LTS

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Bot-7: Altered Structure and Species Composition and Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Altered Flow Regimes	N-A	Long-term	–	LTS	NA	LTS
	CP1 & CP4	Long-term	Altered flow regimes on the upper Sacramento River could alter the structure and species composition or cause the loss of special-status species and habitat	S	Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities.	LTS
	CP2 & CP4A	Long-term	Greater than CP1	S	Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities.	LTS
	CP3 &	Long-term	Greater than CP1 &CP2	S	Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities.	LTS
	CP5	Long-term	Greater than CP1, CP2, & CP3	S	Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities.	LTS

Notes:

[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.

[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.

[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.

[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.

[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Bot-8: Conflict with Approved Local or Regional Plans with Objectives of Riparian Habitat Protection or Watershed Management	N-A	Long-term	–	LTS	NA	LTS
	CP1–CP5	Long-term	Adverse effects on riparian communities along the upper Sacramento River in conflict with local or regional plans	PS	Mitigation Measure Bot-8: Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities.	LTS
Impact Bot-9: Disturbance or Removal of Designated Critical Habitat for Special-Status Species	N-A	Long-term and/or permanent	–	LTS	NA	LTS
	CP1 & CP4	Long-term and/or permanent	Small reduction in the frequency and magnitude of overbank flows could affect vernal pool habitats, if present	LTS	No mitigation needed; thus, none proposed.	LTS
	CP2 & CP4A	Long-term and/or permanent	Greater than CP1	LTS	No mitigation needed; thus, none proposed.	LTS
	CP3	Long-term and/or permanent	Greater than CP1 & CP2	LTS	No mitigation needed; thus, none proposed.	LTS
	CP5	Long-term and/or permanent	Greater than CP1, CP2, & CP3	LTS	No mitigation needed; thus, none proposed.	LTS

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Bot-10: Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Induced Growth	N-A	Permanent	–	LTS	NA	LTS
	CP1 & CP4	Permanent	Increased water supplies for deliveries to water districts in the primary study area	LTS	No mitigation needed; thus, none proposed.	LTS
	CP2 & CP4A	Permanent	Greater than CP1	LTS	No mitigation needed; thus, none proposed.	LTS
	CP3	Permanent	Greater than CP1 & CP2	LTS	No mitigation needed; thus, none proposed.	LTS
	CP3 & CP5	Permanent	Greater than CP1, CP2, & CP3	LTS	No mitigation needed; thus, none proposed.	LTS
Impact Bot-11: Loss of Sensitive Natural Communities or Habitats Resulting from Implementing the Gravel Augmentation Program or Restoring Riparian, Floodplain, and Side Channel Habitats	N-A	NA	–	NI	NA	NI
	CP1–CP3	Long-term	–	NI	No mitigation needed; thus, none proposed.	NI
	CP4–CP5	Long-term	Potential removal of riparian and wetland vegetation or the degradation of riparian and wetland habitats	PS	Mitigation Measure Bot-11: Revegetate Disturbed Areas, Consult with CDFW, and Mitigate Loss of Jurisdictional Waters.	LTS

Notes:

[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.

[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.

[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.

[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.

[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Bot-12: Loss of Special-Status Plants Resulting from Implementing the Gravel Augmentation Program, or Restoring Riparian, Floodplain, and Side Channel Habitats	N-A	NA	–	NI	NA	NI
	CP1–CP3	Long-term	–	NI	No mitigation needed; thus, none proposed.	NI
	CP4–CP5	Long-term	Vegetation removal and gravel placement could result in the loss of special-status plants if present	PS	Mitigation Measure Bot-12: Conduct Preconstruction Surveys for Special-Status Plants and Avoid Special-Status Plant Populations During Construction.	LTS
Impact Bot-13: Spread of Noxious and Invasive Weeds Resulting from Implementing the Gravel Augmentation Program, Restoring Riparian, Floodplain, and Side Channel Habitats	N-A	NA	–	NI	NA	NI
	CP1–CP3	Long-term	–	NI	No mitigation needed; thus, none proposed.	NI
	CP4–CP5	Long-term	Potential spread of noxious and invasive weeds as a result of vegetation clearing and grubbing and an increased number of vectors	PS	Mitigation Measure Bot-13: Implement Weed Management Measures and Revegetation.	LTS

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Bot-14: Altered Structure and Species Composition and Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Altered Flow Regimes on the Lower Sacramento River	N-A	Long-term	–	LTS	NA	LTS
	CP1 & CP4	Long-term	Altered flow regimes on the lower Sacramento River could alter the structure and species composition or cause the loss of special-status species and habitat	S	Mitigation Measure Bot-14: Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities.	LTS
	CP2 & CP4A	Long-term	Greater than CP1	S	Mitigation Measure Bot-14: Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities.	LTS
	CP3		Greater than CP1 & CP2		Mitigation Measure Bot-14: Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities.	LTS
	CP5	Long-term	Greater than CP1, CP2, & CP5	S	Mitigation Measure Bot-14: Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities.	LTS

Notes:

[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.

[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.

[3] NA = not applicable. “–“ = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.

[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.

[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Bot-15: Conflict with Approved Local or Regional Plans with Objectives of Riparian Habitat Protection or Watershed Management Along the Lower Sacramento River	N-A	Long-term	–	PS	NA	SU
	CP1–CP5	Long-term	Adverse effects on riparian communities along the lower Sacramento River in conflict with local or regional plans	PS	Mitigation Measure Bot-15: Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities.	LTS

Notes:

[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.

[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.

[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.

[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.

[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Bot-16: Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Induced Growth Along the Lower Sacramento River and in the Delta	N-A	Long-term	–	LTS	NA	LTS
	CP1 & CP4	Long-term	Increased water supplies for deliveries to water districts in the extended study area along the lower Sacramento River	LTS	No mitigation needed; thus, none proposed.	LTS
	CP2 & CP4A	Long-term	Greater than CP1	LTS	No mitigation needed; thus, none proposed.	LTS
	CP3	Long-term	Greater than CP1 & Cp2	LTS	No mitigation needed; thus, none proposed.	LTS
	CP5	Long-term	Greater than CP1, CP2 & CP3	LTS	No mitigation needed; thus, none proposed.	LTS
Impact Bot-17: Altered Structure and Species Composition and Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Altered Flow Regimes in the CVP/SWP Service Areas	N-A	Long-term	–	LTS	NA	LTS
	CP1 & CP4	Long-term	Altered flow regimes in the CVP/SWP service areas could alter the structure and species composition or cause the loss of special-status species and habitat	LTS	No mitigation needed; thus, none proposed.	LTS
	CP2 & CP4A	Long-term	Greater than CP1	LTS	No mitigation needed; thus, none proposed.	LTS
	CP3		Greater than CP1 & CP2	LTS	No mitigation needed; thus, none proposed.	LTS
	CP5	Long-term	Greater than CP1, CP2, & CP3	LTS	No mitigation needed; thus, none proposed.	LTS

Notes:

1 Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.

2 NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.

3 NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.

4 LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.

5 NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Bot-18: Conflict with Approved Local or Regional Plans with Objectives of Riparian Habitat Protection or Watershed Management in the CVP/SWP Service Areas	N-A	Long-term	–	LTS	NA	LTS
	CP1–, CP5	Long-term	Adverse effects on riparian communities in the CVP/SWP service areas in conflict with local or regional plans	LTS	No mitigation needed; thus, none proposed.	LTS
Impact Bot-19: Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Induced Growth in the CVP/SWP Service Areas	N-A	Long-term	–	LTS	NA	LTS
	CP1 & CP4	Long-term	Increased water supplies for deliveries to water districts in the CVP/SWP service areas	LTS	No mitigation needed; thus, none proposed.	LTS
	CP2 & CP4A	Long-term	Greater than CP1	LTS	No mitigation needed; thus, none proposed.	LTS
	CP3		Greater than CP1 & CP2	LTS	No mitigation needed; thus, none proposed.	LTS
	CP5	Long-term	Greater than CP1, CP2, & CP3	LTS	No mitigation needed; thus, none proposed.	LTS

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Wildlife Resources						
Impact Wild-1: Take and Loss of Habitat for the Shasta Salamander	N-A	NA	–	NI	NA	NI
	CP1	Short-term and long-term	Loss of approximately 42 acres of limestone habitat and 4,056 acres of non-limestone habitat	S	Mitigation Measure Wild-1: Avoid, Relocate, and Acquire Mitigation Lands for Shasta Salamander.	SU
	CP2	Short-term and long-term	Loss of approximately 45 acres of limestone habitat and 4,536 acres of non-limestone habitat	S	Mitigation Measure Wild-1: Avoid, Relocate, and Acquire Mitigation Lands for Shasta Salamander.	SU
	CP3–CP5	Short-term and permanent	Loss of approximately 51 acres of limestone habitat and 5,266 acres of non-limestone habitat	S	Mitigation Measure Wild-1: Avoid, Relocate, and Acquire Mitigation Lands for Shasta Salamander.	SU
Impact Wild-2: Impact on the Foothill Yellow-Legged Frog and Tailed Frog and Their Habitat	N-A	NA	–	NI	NA	NI
	CP1	Short-term and permanent	Loss of approximately habitat	PS	Mitigation Measure Wild-2: Avoid, Relocate, and Acquire Mitigation Lands for Foothill Yellow-Legged Frog and Tailed Frog.	SU
	CP2	Short-term and permanent	Similar to CP1, but greater (larger area of inundation)	PS	Mitigation Measure Wild-2: Avoid, Relocate, and Acquire Mitigation Lands for Foothill Yellow-Legged Frog and Tailed Frog.	SU
	CP3–CP5	Short-term and permanent	Similar to CP1 & CP2, but greater (larger area of inundation)	PS	Mitigation Measure Wild-2: Avoid, Relocate, and Acquire Mitigation Lands for Foothill Yellow-Legged Frog and Tailed Frog.	SU

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Wild-3: Impact on the Northwestern Pond Turtle and Its Habitat	N-A	NA	–	NI	NA	NI
	CP1	Short-term and permanent	Loss of habitat	PS	Mitigation Measure Wild-3: Avoid, Relocate, and Acquire Mitigation Lands for Northwestern Pond Turtle.	SU
	CP2	Short-term and permanent	Similar to CP1, but greater (larger area of inundation)	PS	Mitigation Measure Wild-3: Avoid, Relocate, and Acquire Mitigation Lands for Northwestern Pond Turtle.	SU
	CP3–CP5	Short-term and permanent	Similar to CP1 & CP2, but greater (larger area of inundation)	PS	Mitigation Measure Wild-3: Avoid, Relocate, and Acquire Mitigation Lands for Northwestern Pond Turtle.	SU
Impact Wild-4: Impact on the American Peregrine Falcon	N-A	NA	–	NI	NA	NI
	CP1–CP5	Short-term	Loss of nests	PS	Mitigation Measure Wild-4: Conduct Preconstruction Surveys for the American Peregrine Falcon and Establish Buffers.	LTS

Notes:

1 Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.

2 NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.

3 NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.

4 LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.

5 NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Wild-5: Take and Loss of Habitat for the Bald Eagle	N-A	NA	–	NI	NA	NI
	CP1	Long-term	Inundation of nest trees, increase of prey habitat in primary study area	S	Mitigation Measure Wild-5: Acquire and Preserve Mitigation Lands; Conduct Protocol-Level Surveys for the Bald Eagle and Establish Buffers.	SU
	CP2	Long-term	Similar to CP1, but greater	S	Mitigation Measure Wild-5: Acquire and Preserve Mitigation Lands; Conduct Protocol-Level Surveys for the Bald Eagle and Establish Buffers.	SU
	CP3–CP5	Long-term	Similar to CP1 & CP2, but greater	S	Mitigation Measure Wild-5: Acquire and Preserve Mitigation Lands; Conduct Protocol-Level Surveys for the Bald Eagle and Establish Buffers.	SU
Impact Wild-6: Loss of Dispersal Habitat for the Northern Spotted Owl	N-A	NA	–	NI	NA	NI
	CP1	Short-term and permanent	Loss of nests and habitat	PS	Mitigation Measure Wild-6: Acquire and Preserve Mitigation Lands, Habitat Enhancement.	LTS
	CP2	Short-term and permanent	Similar to CP1, but greater (larger area of inundation)	PS	Mitigation Measure Wild-6: Acquire and Preserve Mitigation Lands, Habitat Enhancement.	LTS
	CP3–CP5	Short-term and permanent	Similar to CP1 & CP2, but greater (larger area of inundation)	PS	Mitigation Measure Wild-6: Acquire and Preserve Mitigation Lands, Habitat Enhancement.	LTS

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable. TS = too speculative for meaningful consideration. NDHA = not disproportionately high and adverse. DHA = disproportionately high and adverse.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Wild-7: Impact on the Purple Martin and Its Habitat	N-A	NA	–	NI	NA	NI
	CP1	Short-term and long-term	Loss of potential nest sites in primary study area	S	Mitigation Measure Wild-7: Conduct a Preconstruction Survey for Purple Martin and Establish Buffers.	SU
	CP2	Short-term and long-term	Similar to CP1, but greater loss of nest sites	S	Mitigation Measure Wild-7: Conduct a Preconstruction Survey for Purple Martin and Establish Buffers.	SU
	CP3–CP5	Short-term and long-term	Similar to CP1 &CP2, but greater loss of nest sites	S	Mitigation Measure Wild-7: Conduct a Preconstruction Survey for Purple Martin and Establish Buffers.	SU
Impact Wild-8: Impacts on the Willow Flycatcher, Vaux's Swift, Yellow Warbler, and Yellow-Breasted Chat and Their Foraging and Nesting Habitat	N-A	NA	–	NI	NA	NI
	CP1	Short-term and permanent	Loss of nests and habitat	PS	Mitigation Measure Wild-8: Acquire and Preserve Mitigation Lands; Conduct a Preconstruction Survey for the Willow Flycatcher, Vaux's Swift, Yellow Warbler, and Yellow-Breasted Chat and Establish Buffers.	SU
	CP2	Short-term and permanent	Similar to CP1, but greater (larger area of inundation)	PS	Mitigation Measure Wild-8: Acquire and Preserve Mitigation Lands; Conduct a Preconstruction Survey for the Willow Flycatcher, Vaux's Swift, Yellow Warbler, and Yellow-Breasted Chat and Establish Buffers.	SU

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Wild-8: Impacts on the Willow Flycatcher, Vaux's Swift, Yellow Warbler, and Yellow-Breasted Chat and Their Foraging and Nesting Habitat (contd.)	CP3–CP5	Short-term and permanent	Similar to CP1 & CP2, but greater (larger area of inundation)	PS	Mitigation Measure Wild-8: Acquire and Preserve Mitigation Lands; Conduct a Preconstruction Survey for the Willow Flycatcher, Vaux's Swift, Yellow Warbler, and Yellow-Breasted Chat and Establish Buffers.	SU
Impact Wild-9: Impacts on the Long-Eared Owl, Northern Goshawk, Cooper's Hawk, Great Blue Heron, and Osprey and Their Foraging and Nesting Habitat	N-A	NA	–	NI	NA	NI
	CP1	Short-term and permanent	Loss of nests and habitat	PS	Mitigation Measure Wild-9: Acquire and Preserve Mitigation Lands; Conduct a Preconstruction Survey for the Long-Eared Owl, Northern Goshawk, Cooper's Hawk, Great Blue Heron, and Osprey and Establish Buffers.	SU
	CP2	Short-term and permanent	Similar to CP1, but greater (larger area of inundation)	PS	Mitigation Measure Wild-9: Acquire and Preserve Mitigation Lands; Conduct a Preconstruction Survey for the Long-Eared Owl, Northern Goshawk, Cooper's Hawk, Great Blue Heron, and Osprey and Establish Buffers.	SU
	CP3–CP5	Short-term and permanent	Similar to CP1 & CP2, but greater (larger area of inundation)	PS	Mitigation Measure Wild-9: Acquire and Preserve Mitigation Lands; Conduct a Preconstruction Survey for the Long-Eared Owl, Northern Goshawk, Cooper's Hawk, Great Blue Heron, and Osprey and Establish Buffers.	SU

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Wild-10: Take and Loss of Habitat for the Pacific Fisher	N-A	NA	–	NI	NA	NI
	CP1	Short-term and permanent	Construction-related mortality and loss of habitat	PS	Mitigation Measure Wild-10: Acquire and Preserve Mitigation Lands; Conduct Preconstruction Surveys for the Pacific Fisher and Establish Buffers.	SU
	CP2	Short-term and permanent	Similar to CP1, but greater (larger area of inundation)	PS	Mitigation Measure Wild-10: Acquire and Preserve Mitigation Lands; Conduct Preconstruction Surveys for the Pacific Fisher and Establish Buffers.	SU
	CP3–CP5	Short-term and permanent	Similar to CP1 & CP2, but greater (larger area of inundation)	PS	Mitigation Measure Wild-10: Acquire and Preserve Mitigation Lands; Conduct Preconstruction Surveys for the Pacific Fisher and Establish Buffers.	SU

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Wild-11: Impacts on Special-Status Bats (Pallid Bat, Spotted Bat, Western Red Bat, Western Mastiff Bat, Townsend's Big-Eared Bat, Long-Eared Myotis, and Yuma Myotis), the American Marten, and Ringtails and Their Habitat	N-A	NA	–	NI	NA	NI
	CP1	Short-term and permanent	Construction-related mortality and loss of habitat in primary study area	PS	Mitigation Measure Wild-11: Acquire and Preserve Mitigation Lands; Conduct a Preconstruction Survey for Special-Status Bats, American Marten, and Ringtails and Establish Buffers.	SU
	CP2	Short-term and long-term	Similar to CP1, but greater (larger area of inundation)	PS	Mitigation Measure Wild-11: Acquire and Preserve Mitigation Lands; Conduct a Preconstruction Survey for Special-Status Bats, American Marten, and Ringtails and Establish Buffers.	SU
	CP3–CP5	Short-term and long-term	Similar to CP1 & CP2, but greater (larger area of inundation)	PS	Mitigation Measure Wild-11: Acquire and Preserve Mitigation Lands; Conduct a Preconstruction Survey for Special-Status Bats, American Marten, and Ringtails and Establish Buffers.	SU

Notes:

[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.

[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.

[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.

[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.

[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Wild-12: Impacts on Special-Status Terrestrial Mollusks (Shasta Sideband, Wintu Sideband, Shasta Chaparral, and Shasta Hesperian) and Their Habitat	N-A	NA	–	NI	NA	NI
	CP1	Short-term and permanent	Ground-disturbing activities, inundation of habitat	S	Mitigation Measure Wild-12: Avoid Suitable Habitat; Acquire and Preserve Mitigation Lands for Special-Status Terrestrial Mollusks.	SU
	CP2	Short-term and permanent	Similar to CP1, but greater (larger area of inundation)	S	Mitigation Measure Wild-12: Avoid Suitable Habitat; Acquire and Preserve Mitigation Lands for Special-Status Terrestrial Mollusks.	SU
	CP3–CP5	Short-term and permanent	Similar to CP1 & CP2, but greater (larger area of inundation)	S	Mitigation Measure Wild-12: Avoid Suitable Habitat; Acquire and Preserve Mitigation Lands for Special-Status Terrestrial Mollusks.	SU
Impact Wild-13: Permanent Loss of General Wildlife Habitat	N-A	NA	–	NI	NA	NI
	CP1	Permanent	Inundation of habitat	PS	Mitigation Measure Wild-13: Acquire and Preserve Mitigation Lands for Permanent Loss of General Wildlife Habitat.	SU
	CP2	Permanent	Similar to CP1, but greater (larger area of inundation)	PS	Mitigation Measure Wild-13: Acquire and Preserve Mitigation Lands for Permanent Loss of General Wildlife Habitat.	SU
	CP3–CP5	Permanent	Similar to CP1 & CP2, but greater (larger area of inundation)	PS	Mitigation Measure Wild-13: Acquire and Preserve Mitigation Lands for Permanent Loss of General Wildlife Habitat.	SU

Notes:

1 Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.

2 NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.

3 NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.

4 LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.

5 NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Wild-14: Impacts on Other Birds of Prey (Red-Tailed Hawk and Red-Shouldered Hawk) and Migratory Bird Species (American Robin, Anna's Hummingbird) and Their Foraging and Nesting Habitat	N-A	NA	–	NI	NA	NI
	CP1	Short-term and long-term	Loss of nests and habitat	PS	Mitigation Measure Wild-14: Acquire and Preserve Mitigation Lands and Conduct Preconstruction Surveys for Other Nesting Raptors and Migratory Birds and Establish Buffers.	SU
	CP2	Short-term and long-term	Similar to CP1, but greater (larger area of inundation)	PS	Mitigation Measure Wild-14: Acquire and Preserve Mitigation Lands and Conduct Preconstruction Surveys for Other Nesting Raptors and Migratory Birds and Establish Buffers.	SU
	CP3–CP5	Short-term and long-term	Similar to CP1 & CP2, but greater (larger area of inundation)	PS	Mitigation Measure Wild-14: Acquire and Preserve Mitigation Lands and Conduct Preconstruction Surveys for Other Nesting Raptors and Migratory Birds and Establish Buffers.	SU

Notes:

1 Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.

2 NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.

3 NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.

4 LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.

5 NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Wild-15: Loss of Critical Deer Winter and Fawning Range	N-A	NA	–	NI	NA	NI
	CP1	Short-term and long-term	Loss of wintering and fawning range	PS	Mitigation Measure Wild-15: Acquire and Preserve Mitigation Lands for Permanent Loss of Critical Deer Wintering and Fawning Range.	SU
	CP2	Short-term and long-term	Similar to CP1, but greater (larger area of inundation)	PS	Mitigation Measure Wild-15: Acquire and Preserve Mitigation Lands for Permanent Loss of Critical Deer Wintering and Fawning Range.	SU
	CP3–CP5	Short-term and long-term	Similar to CP1 & CP2, but greater (larger area of inundation)	PS	Mitigation Measure Wild-15: Acquire and Preserve Mitigation Lands for Permanent Loss of Critical Deer Wintering and Fawning Range.	SU
Impact Wild-16: Take and Loss of California Red-Legged Frog	N-A	NA	–	NI	NA	NI
	CP1–CP5	Long-term	[TBD]	[TBD]	[TBD]	[TBD]

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Wild-17: Impacts on Riparian-Associated Special-Status Wildlife Resulting from Modifications to the Existing Flow Regime in the Primary Study Area	N-A	Long-term	–	LTS	NA	LTS
	CP1 & CP4	Long-term	Adverse effects on habitat for a variety of riparian-dependent special-status species	PS	Mitigation Measure Wild-17: Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities.	LTS
	CP2 & CP4A	Long-term	CP2 similar to CP1 but greater in magnitude	PS	Mitigation Measure Wild-17: Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities.	LTS
	CP3–CP5	Long-term	CP3 & CP5 similar to CP1, CP2, and CP4, but greater in magnitude;	PS	Mitigation Measure Wild-17: Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities.	LTS

Notes:

1 Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.

2 NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.

3 NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.

4 LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.

5 NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Wild-18: Impacts on Bank Swallow in the Primary Study Area Resulting from Modifications of Geomorphic Processes	N-A	Long-term	Reduction in rate of bank erosion	LTS	NA	LTS
	CP1 & CP4,	Long-term		LTS	No mitigation needed; thus, none proposed.	LTS
	CP2 & CP4A	Long-term	CP2 similar to CP1, but greater in magnitude	LTS	No mitigation needed; thus, none proposed.	LTS
	CP3 &CP5	Long-term	CP3 & CP5 similar to CP1 & CP2, but greater in magnitude	LTS	No mitigation needed; thus, none proposed.	LTS
Impact Wild-19: Disturbance or Removal of Vernal Pool Habitat for Special-Status Wildlife from Changes in Flow Regime	N-A	NA	–	NI	NA	NI
	CP1-CP5	NA	–	NI	No mitigation needed; thus, none proposed.	NI
Impact Wild-20: Consistency with Local and Regional Plans with Goals of Promoting Riparian Habitat in the Primary Study Area	N-A	NA	–	NI	NA	NI
	CP1 & CP4,	Long-term	Goals of local and regional plans could be more difficult to attain	PS	Mitigation Measure Wild-20: Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities.	LTS
	CP2 & CP4A	Long-term	CP2 & CP4A similar to CP1, but greater in magnitude	PS	Mitigation Measure Wild-20: Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities.	LTS

Notes:

[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.

[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.

[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.

[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.

[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Wild-20: Consistency with Local and Regional Plans with Goals of Promoting Riparian Habitat in the Primary Study Area (contd.)	CP3 &CP5	Long-term	CP3 & CP5 similar to CP1–CP2, but greater in magnitude	PS	Mitigation Measure Wild-20: Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities.	LTS
Impact Wild-21: Impacts on Riparian-Associated Special-Status Wildlife Resulting from the Gravel Augmentation Program	N-A	NA	–	NI	NA	NI
	CP1–CP3	NA	–	NI	No mitigation needed; thus, none proposed.	NI
	CP4–CP5	Long-term	–	PS	Mitigation Measure Wild-21: Conduct Preconstruction Surveys for Elderberry Shrubs, Northwestern Pond Turtle, and Nesting Riparian Raptors and Other Nesting Birds. Avoid Removal or Degradation of Elderberry Shrubs and Avoid Vegetation Removal near Active Nest Sites.	LTS

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Wild-22: Impacts on Riparian-Associated Special-Status Wildlife Species Resulting from Restoration Projects	N-A	NA	–	NI	NA	NI
	CP1–CP3	NA	–	NI	No mitigation needed; thus, none proposed.	NI
	CP4–CP5	Long-term	–	PS	Mitigation Measure Wild-22: Implement Mitigation Measure Wild-21: Conduct Preconstruction Surveys for Elderberry Shrubs, Northwestern Pond Turtle, and Nesting Riparian Raptors and Other Nesting Birds. Avoid Removal or Degradation of Elderberry Shrubs and Avoid Vegetation Removal near Active Nest Sites.	LTS
Impact Wild-23: Impacts on Riparian-Associated and Aquatic Special-Status Wildlife Resulting from Modifications to Existing Flow Regimes in the Lower Sacramento River and Delta	N-A	Long-term	–	LTS	NA	LTS
	CP1–CP5	Long-term	Adverse effects on habitat for a variety of riparian-dependent special-status species	PS	Mitigation Measure Wild-23: Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities.	LTS

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable. [5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Wild-24: Impacts on Bank Swallow Along the Lower Sacramento River Resulting from Modifications of Geomorphic Processes	N-A	Long-term	–	LTS	NA	LTS
	CP1–CP5	Long-term	Reduction in rate of bank erosion	LTS	No mitigation needed; thus, none proposed.	LTS
Impact Wild-25: Disturbance or Removal of Vernal Pool Habitat for Special-Status Wildlife Along the Lower Sacramento River and in the Delta from Changes in Flow Regime of the Sacramento River and Affected Tributaries, and Changes in Seasonal Water Availability	N-A	NA	–	NI	NA	NI
	CP1–CP5	NA	–	NI	No mitigation needed; thus, none proposed.	NI
Impact Wild-26: Consistency with Local and Regional Plans with Goals of Promoting Riparian Habitat along the Lower Sacramento River and in the Delta	N-A	NA	–	NI	NA	NI
	CP1-CP5	Long-term	Goals of local and regional plans could be more difficult to attain	PS	Mitigation Measure Wild-26: Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities.	LTS

Notes:

[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.

[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.

[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.

[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.

[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Wild-27: Impacts on Riparian-Associated or Aquatic Special-Status Wildlife in the CVP/SWP Service Areas Resulting from Modifications to Existing Flow Regimes	N-A	NA	–	LTS	NA	LTS
	CP1-CP5	Long-term	–	LTS	No mitigation needed; thus, none proposed.	LTS
Cultural Resources						
Impact Culture-1: Disturbance or Destruction of Archaeological and Historical Resources Due to Construction or Inundation	N-A	NA	–	NI	NA	NI
	CP1	Permanent	355 localities potentially containing historic-era remains and 212±54 prehistoric resources within inundation area	S	Mitigation Measure Culture-1: Develop and Implement measures identified in an NHPA Section 106 MOA or PA	LTS
	CP2	Permanent	371 localities potentially containing historic-era remains and 224±57 prehistoric resources within inundation area	S	Mitigation Measure Culture-1: Develop and Implement measures identified in an NHPA Section 106 MOA or PA.	LTS
	CP3–CP5	Permanent	391 localities potentially containing historic-era remains and 243±63 prehistoric resources within inundation area	S	Mitigation Measure Culture-1: Develop and Implement measures identified in an NHPA Section 106 MOA or PA.	LTS
Impact Culture-2: Inundation of Traditional Cultural Properties	N-A	NA	–	NI	NA	NI
	CP1–CP5	Permanent	–	S	Mitigation Measure Culture-2: Adverse effects will be avoided, minimized, or mitigated through project redesign, when warranted, or through the development and implementation of an MOA or PA.	SU

Notes:

[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.

[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.

[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.

[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.

[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Culture-3: Disturbance or Destruction of Archaeological and Historical Resources near the Upper Sacramento River Due to Construction	N-A	NA	–	NI	NA	NI
	CP1-CP3	Permanent		NI	No mitigation needed; thus, none proposed.	NI
	CP4–CP5	Permanent	–	S	Mitigation Measure Culture-3: Implement Mitigation Measure Culture-1: Develop and Implement measures identified in an NHPA Section 106 MOA or PA.	LTS
Indian Trust Assets						
No impacts to ITAs were identified						
Socioeconomics, Population, and Housing						
Impact Socio-1 (No-Action): Potential for Reduced Employment Opportunities for Lower Sacramento River and Delta Area Residents	N-A	Short-term	Potential periodic water and power supply disruptions	PS	NA	PS
Impact Socio-1 (CP1-CP5) Short-Term Increase in Population and Housing Demand in the Primary Study Area Resulting from Construction-Related Activities	CP1–CP5	Short-term	Construction labor is expected to come from the local population	LTS	No mitigation needed; thus, none proposed.	LTS

Notes:

[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.

[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.

[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.

[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.

[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration [2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Socio-2 (No-Action): Potential for Temporary Disruptions in Business and Industrial Activity in the Lower Sacramento River and Delta Area Impact Socio-2 (CP1–CP5): Short-Term Increases in Direct, Indirect, and Induced Employment in the Primary Study Area Related to Construction Activities	N-A	Temporary	Potential periodic water or power supply disruptions	PS	NA	PS
	CP1	Temporary	300 new construction jobs, 400 new indirect jobs, and 610 induced jobs	B	No mitigation needed; thus, none proposed.	B
	CP2	Temporary	300 new direct construction jobs, 600 new indirect jobs, and 600 induced jobs	B	No mitigation needed; thus, none proposed.	B
	CP3, CP4, & CP4A	Short-term	350 new direct construction jobs, 450 new indirect jobs, and 700 induced jobs	B	No mitigation needed; thus, none proposed.	B
	CP5	Short-term	360 new direct construction jobs, 470 new indirect jobs, and 710 induced jobs	B	No mitigation needed; thus, none proposed.	B
Impact Socio-3 (No-Action): Potential for Reduced Employment Opportunities for Residents Within the CVP and SWP Service Areas Impact Socio-3 (CP1–CP5): Potential for Temporary Reduction in the Labor Force of Related Industrial Sectors in the Primary Study Area as a Result of Direct Construction-Related Employment	N-A	Short-term	Potential water or power supply disruptions	PS	NA	PS
	CP1–CP5	Short-term	–	LTS	No mitigation needed; thus, none proposed.	LTS

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. “–“ = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Socio-4 (No-Action): Potential for Temporary Disruptions in Business and Industrial Activity in the CVP and SWP Service Areas Impact Socio-4 (CP1–CP5): Short-Term Increases in Direct, Indirect, and Induced Personal Income Paid to Employees in the Primary Study Area Hired for Construction-Related Activities	N-A	Temporary	Potential water or power supply disruptions	PS	NA	PS
	CP1	Short-term	$134.2 million in personal annual incomes in the local economic study area	B	No mitigation needed; thus, none proposed.	B
	CP2	Short-term	$132.8million in personal annual incomes	B	No mitigation needed; thus, none proposed.	B
	CP3	Short-term	$153.3 million in personal annual incomes	B	No mitigation needed; thus, none proposed.	B
	CP4	Short-term	$154.2 million in personal annual incomes	B	No mitigation needed; thus, none proposed.	B
	CP4 A	Short-term	$154.3 million in personal annual incomes			
	CP5	Short-term	$156.5 million in personal annual incomes	B	No mitigation needed; thus, none proposed.	B
Impact Socio-5: Short-Term Increases in Sales and Profits for Businesses in the Primary Study Area that Support the Construction Industry	N-A	NA	–	NA	NA	NA
	CP1	Short-term	– (4.5-year construction period)	B	No mitigation needed; thus, none proposed.	B
	CP2	Short-term	Similar to CP1, but more beneficial (5-year construction period)	B	No mitigation needed; thus, none proposed.	B
	CP3–CP5	Short-term	Similar to CP1 & CP2, but more beneficial (5-year construction period)	B	No mitigation needed; thus, none proposed.	B

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Socio-6: Short-Term Increase in State and Local Sales Tax Revenues in the Primary Study Area from Construction-Related Personal Income and Purchases	N-A	NA	–	NA	NA	NA
	CP1	Short-term	Increased personal income, direct income and indirect and induced income during the construction period	B	No mitigation needed; thus, none proposed.	B
	CP2	Short-term	Similar to, but more beneficial than CP1	B	No mitigation needed; thus, none proposed.	B
	CP3	Short-term	Similar to, but more beneficial than CP2	B	No mitigation needed; thus, none proposed.	B
	CP4-CP5	Short-term	Similar to, but more beneficial than CP3	B	No mitigation needed; thus, none proposed.	B
Impact Socio-7: Long-Term Reduction in the Adverse Economic Effects of Flooding in the Primary Study Area	N-A	NA	–	NA	NA	NA
	CP1	Long-term	Reduced risk of flooding below Shasta Dam	B	No mitigation needed; thus, none proposed.	B
	CP2	Long-term	Similar to, but more beneficial than CP1	B	No mitigation needed; thus, none proposed.	B
	CP3–CP5	Long-term	Similar to, but more beneficial than CP1 & CP2	B	No mitigation needed; thus, none proposed.	B
Impact Socio-8: Long-Term Increases in Direct Employment in the Primary Study Area Related to Project Operations	N-A	NA	–	NA	NA	NA
	CP1–CP5	Long-term	Two or more new maintenance-related positions for the Shasta Dam facilities	B	No mitigation needed; thus, none proposed.	B

Notes:

[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.

[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.

[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.

[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.

[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Socio-9: Potential Temporary Increase in Indirect Employment in Construction-Related Businesses of the Lower Sacramento River and Delta	N-A	NA	–	NA	NA	NA
	CP1	Short-term	Temporary increase in short-term, construction-related, State sales and income tax revenues	B	No mitigation needed; thus, none proposed.	B
	CP2	Short-term	Similar to CP1, but more beneficial than CP1	B	No mitigation needed; thus, none proposed.	B
	CP3–CP5	Short-term	Similar to, but more beneficial than CP1 & CP2	B	No mitigation needed; thus, none proposed.	B
Impact Socio-10: Short-Term Increases in Sales and Profits for Businesses in the Lower Sacramento River and Delta Area That Support the Construction Industry	N-A	NA	–	NA	NA	NA
	CP1	Short-term	Some local purchase of construction materials	B	No mitigation needed; thus, none proposed.	B
	CP2	Short-term	Similar to CP1, but more beneficial	B	No mitigation needed; thus, none proposed.	B
	CP3–CP5	Short-term	Similar to CP1 & CP2, but more beneficial	B	No mitigation needed; thus, none proposed.	B
Impact Socio-11: Short-Term Increase in State Sales and Income Tax Revenues in the Lower Sacramento River and Delta Area from Construction-Related Personal Income and Purchases	N-A	NA	–	NA	NA	NA
	CP1	Short-term	Short-term increase in State sales and income tax revenues	B	No mitigation needed; thus, none proposed.	B
	CP2	Short-term	Similar to CP1, but more beneficial	B	No mitigation needed; thus, none proposed.	B
	CP3–CP5	Short-term	Similar to CP1 & CP2, but more beneficial	B	No mitigation needed; thus, none proposed.	B

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Socio-12: Long-Term Reduction in the Adverse Economic Effects of Flooding in the Lower Sacramento River and Delta Area	N-A	NA	–	NA	NA	NA
	CP1	Long-term	Reduced risk of flooding below Shasta Dam	B	No mitigation needed; thus, none proposed.	B
	CP2	Long-term	Similar to CP1, but more beneficial	B	No mitigation needed; thus, none proposed.	B
	CP3–CP5	Long-term	Similar to CP1 & CP2, but more beneficial	B	No mitigation needed; thus, none proposed.	B
Impact Socio-13: Short-Term Increases in Sales and Profits for Businesses in the CVP and SWP Service Areas That Support the Construction Industry	N-A	NA	–	NA	NA	NA
	CP1	Short-term	Some purchase of construction materials within the extended study area	B	No mitigation needed; thus, none proposed.	B
	CP2	Short-term	Similar to CP1, but more beneficial	B	No mitigation needed; thus, none proposed.	B
	CP3–CP5	Short-term	Similar to CP1 & CP2, but more beneficial	B	No mitigation needed; thus, none proposed.	B
Impact Socio-14: Potential Temporary Reduction in Shasta Project Water or Hydropower Supplied to the CVP and SWP Service Areas During Construction	N-A	NA	–	NA	NA	NA
	CP1	Short-term	Temporary shortages in water or hydropower caused by lowered reservoir levels during construction	PS	Mitigation Measure Socio-14: Secure Replacement Water or Hydropower During Project Construction.	LTS
	CP2	Short-term	Similar to CP1, but greater construction period duration	PS	Mitigation Measure Socio-14: Secure Replacement Water or Hydropower During Project Construction.	LTS
	CP3–CP5	Short-term	Similar to CP1 & CP2, but greater construction period duration	PS	Mitigation Measure Socio-14: Secure Replacement Water or Hydropower During Project Construction.	LTS

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Socio-15: Short-Term Increase in State Sales and Income Tax Revenues in the CVP and SWP Service Areas from Construction-Related Personal Income and Purchases	N-A	NA	–	NA	NA	NA
	CP1	Short-term	Temporary increase in short-term, construction-related, State sales and income tax revenues	B	No mitigation needed; thus, none proposed.	B
	CP2	Short-term	Similar to CP1, but more beneficial than CP1	B	No mitigation needed; thus, none proposed.	B
	CP3–CP5	Short-term	Similar to, but more beneficial than CP1 & CP2	B	No mitigation needed; thus, none proposed.	B
Impact Socio-16: Long-Term Increase in Agricultural Income and Jobs in the CVP and SWP Service Areas as a Result of Improved Water Availability and Reliability	N-A	NA	–	NA	NA	NA
	CP1	Long-term	Increased agricultural net income due to improved water reliability	B	No mitigation needed; thus, none proposed.	B
	CP2	Long-term	Similar to CP1, but more beneficial	B	No mitigation needed; thus, none proposed.	B
	CP3–CP5	Long-term	Similar to CP1 & CP2, but more beneficial	B	No mitigation needed; thus, none proposed.	B
Impact Socio-17: Reduction in Risk of Potential Water and Power Shortages (and Related Economic Activity) in the CVP and SWP Service Areas as a Result of Long-Term Improvements to Water and Power Supply Reliability	N-A	NA	–	NA	NA	NA
	CP1	Long-term	Reduced risk of urban water and power shortages due to improved water reliability	B	No mitigation needed, thus none proposed.	B
	CP2	Long-term	Similar to CP1, but more beneficial			
	CP3–CP5	Long-term	Similar to CP1 & CP2, but more beneficial	B	No mitigation needed; thus, none proposed.	B

Notes:

[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.

[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.

[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.

[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.

[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Land Use and Planning						
Impact LU-1: Disruption of Existing Land Uses (Shasta Lake and Vicinity and Upper Sacramento River)	N-A	NA	–	NI	NA	NI
	CP1	Short-term and long-term	Short-term disruption of land uses of parcels around Shasta Lake and vicinity during construction and relocation activities; long-term disruptions of land use could also result from project operations.	PS	Mitigation Measure LU-1: Minimize and/or Avoid Temporary Disruptions to Local Communities.	SU
	CP2	Short-term and long-term	Similar to CP1 but greater	PS	Mitigation Measure LU-1: Minimize and/or Avoid Temporary Disruptions to Local Communities.	SU
	CP3–CP5	Short-term and long-term	Similar to CP1 & CP2 but greater	PS	Mitigation Measure LU-1: Minimize and/or Avoid Temporary Disruptions to Local Communities.	SU
Impact LU-2: Conflict with Existing Land Use Goals and Policies of Affected Jurisdictions (Shasta Lake and Vicinity and Upper Sacramento River)	N-A	NA	–	NI	NA	NI
	CP1	Short-term and long-term	Inundation and relocation that could conflict with land use goals and policies	PS	Mitigation Measure LU-2: Minimize and/or Avoid Conflicts with Land Use Goals and Policies.	SU
	CP2	Short-term and long-term	Similar to CP1 but greater	PS	Mitigation Measure LU-2: Minimize and/or Avoid Conflicts with Land Use Goals and Policies.	SU
	CP3–CP5	Short-term And long-term	Similar to CP1 & CP2 but greater	PS	Mitigation Measure LU-2: Minimize and/or Avoid Conflicts with Land Use Goals and Policies.	SU

Notes:

[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.

[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.

[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.

[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.

[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact LU-3: Disruption of Existing Land Uses (Lower Sacramento River, Delta, CVP/SWP Service Areas)	N-A	NA	–	NI	NA	NI
	CP1–CP5	NA	–	NI	No mitigation needed; thus, none proposed.	NI
Impact LU-4: Conflict with Existing Land Use Goals and Policies of Affected Jurisdictions (Lower Sacramento River, Delta, CVP/SWP Service Areas)	N-A	NA	–	NI	NA	NI
	CP1–CP5	NA	–	NI	No mitigation needed; thus, none proposed.	NI
Recreation and Public Access						
Impact Rec-1 (No-Action): Increased Use of Shasta Lake Recreation Facilities and Demand for Recreation Opportunities on Shasta Lake and in the Vicinity Impact Rec-1 (CP1–CP5): Seasonal Inundation of Shasta Lake Recreation Facilities or Portions of Recreation Facilities and Public Access at Pool Elevations Above the Current Full Pool Elevation	N-A	Short-term	–	LTS	NA	LTS
	CP1	Short-term	99 affected facilities and infrastructure elements	LTS	No mitigation needed; thus, none proposed.	LTS
	CP2	Short-term	122 affected facilities and infrastructure elements	LTS	No mitigation needed; thus, none proposed.	LTS
	CP3–CP5	Short-term	163 affected facilities and infrastructure elements	LTS	No mitigation needed; thus, none proposed.	LTS

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Rec-2 (No-Action): Increased Use and Demand for Recreation Opportunities on the Upper Sacramento River Impact Rec-2 (CP1– CP5): Temporary Construction-Related Disruption of Recreation Access and Activities at and near Shasta Dam	N-A	Long-term	–	LTS	NA	LTS
	CP1	Short-term	Affect access to local recreation activities during construction period	PS	Mitigation Measure Rec-2: Provide Information About and Improve Alternate Recreation Access and Opportunities to Mitigate the Temporary Loss of Recreation Access and Opportunities During Construction at Shasta Dam.	LTS
	CP2	Short-term	Similar to CP1, but longer construction period	PS	Mitigation Measure Rec-2: Provide Information About and Improve Alternate Recreation Access and Opportunities to Mitigate the Temporary Loss of Recreation Access and Opportunities During Construction at Shasta Dam.	LTS
	CP3–CP5	Short-term	Similar to CP1 & CP2, but longer construction period	PS	Mitigation Measure Rec-2: Provide Information About and Improve Alternate Recreation Access and Opportunities to Mitigate the Temporary Loss of Recreation Access and Opportunities During Construction at Shasta Dam.	LTS

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Rec-3 (No-Action): Increased Use and Demand for Recreation Opportunities on the Lower Sacramento River and in the Delta Impact Rec-3 (CP1–CP5): Effects on Boating and Other Recreation Use and Enjoyment of Shasta Lake as a Result of Changes in the Annual Drawdown of the Reservoir	N-A	Long-term	–	LTS	NA	LTS
	CP1–CP5	Long-term	–	LTS	No mitigation needed; thus, none proposed.	LTS
Impact Rec-4 (No-Action): Increased Use and Demand for Recreation Opportunities in the CVP and SWP Service Areas Impact Rec-4 (CP1–CP5): Increased Hazards to Boaters and Other Recreationists at Shasta Lake from Standing Timber and Stumps Remaining in Untreated Areas of the Inundation Zone	N-A	Long-term	–	LTS	NA	LTS
	CP1	Long-term	Approximately 730 acres of newly inundated area would receive no vegetation treatment, 220 acres would have overstory removal, and 150 acres would have complete removal	S	Mitigation Measure Rec-4: Provide Information to Shasta Lake Visitors About Potential Safety Hazards in Newly Inundated Areas from Standing Timber and Stumps.	LTS
	CP2	Long-term	Approximately 1,167 acres of newly inundated area would receive no vegetation treatment, 350 acres would have overstory removal, and 240 acres would have complete removal	S	Mitigation Measure Rec-4: Provide Information to Shasta Lake Visitors About Potential Safety Hazards in Newly Inundated Areas from Standing Timber and Stumps.	LTS
	CP3–CP5	Long-term	Approximately 1,738 acres of newly inundated area would receive no vegetation treatment, 500 acres would have overstory removal, and 340 acres would have complete removal	S	Mitigation Measure Rec-4: Provide Information to Shasta Lake Visitors About Potential Safety Hazards in Newly Inundated Areas from Standing Timber and Stumps.	LTS

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Rec-5 (CP1–CP5): Seasonal Inundation of Portions of Recreation Facilities or Informal River Access Sites as a Result of Increased River Flows	N-A	NA	–	NI	NA	NI
	CP1 & CP4	Long-term	Flow increases of <8 percent; inundation of small additional area	LTS	No mitigation needed; thus, none proposed.	LTS
	CP2 & CP4A	Long-term	Similar to CP1, but greater	LTS	No mitigation needed; thus, none proposed.	LTS
	CP3	Long-term	Similar to CP1 & CP2,, but greater	LTS	No mitigation needed; thus, none proposed.	LTS
	CP5	Long-term	Similar to CP1, CP2, & CP3, but greater	LTS	No mitigation needed; thus, none proposed.	LTS
Impact Rec-6 (CP1–CP5): Increased Difficulty for Boaters in Using the Sacramento River as a Result of Increased River Flows	N-A	NA	–	NI	NA	NI
	CP1 & CP4	Long-term	Flow increases of <8 percent; inundation of small additional area	LTS	No mitigation needed; thus, none proposed.	LTS
	CP2 & CP4A	Long-term	Similar to CP1, but greater	LTS	No mitigation needed; thus, none proposed.	LTS
	CP3	Long-term	Similar to CP1 & CP2, but greater	LTS	No mitigation needed; thus, none proposed.	LTS
	CP5	Long-term	Similar to CP1, CP2, & CP3, but greater	LTS	No mitigation needed; thus, none proposed.	LTS
Impact Rec-7 (CP1–CP5): Increased Difficulty for Swimmers and Waders in Using the Sacramento River as a Result of Increased River Flows	N-A	NA	–	NI	NA	NI
	CP1 & CP4	Long-term	Flow increases of <8 percent; inundation of small additional area	LTS	No mitigation needed; thus, none proposed.	LTS
	CP2 & CP4A	Long-term	Similar to CP1, but greater	LTS	No mitigation needed; thus, none proposed.	LTS
	CP3	Long-term	Similar to CP1 & CP2, , but greater	LTS	No mitigation needed; thus, none proposed.	LTS
	CP5	Long-term	Similar to CP1, CP2, & CP3, but greater	LTS	No mitigation needed; thus, none proposed.	LTS

Notes:

[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.

[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.

[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.

[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.

[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Rec-8 (CP1–CP5): Increased Usability of the Sacramento River for Boating and Water-Contact Recreation as a Result of Decreased River Flows	N-A	NA	–	NI	NA	NI
	CP1 & CP4	Long-term	Flow decreases of <7 percent; inundation of small additional area	LTS	No mitigation needed; thus, none proposed.	LTS
	CP2 & CP4A	Long-term	Similar to CP1, but greater	LTS	No mitigation needed; thus, none proposed.	LTS
	CP3	Long-term	Similar to CP1 & CP2, but greater	LTS	No mitigation needed; thus, none proposed.	LTS
	CP5	Long-term	Similar to CP1, CP2, & CP3 but greater	LTS	No mitigation needed; thus, none proposed.	LTS
Impact Rec-9 (CP1–CP5): Enhanced Angling Opportunities in the Upper Sacramento River as a Result of Improved Flows and Reduced Water Temperatures	N-A	NA	NA	NI	NA	NI
	CP1	Long-term	Provide enhanced sport angling opportunities for all four runs of Chinook salmon	B	No mitigation needed; thus, none proposed.	B
	CP2 & CP5	Long-term	Similar to CP1, but greater	B	No mitigation needed; thus, none proposed.	B
	CP3	Long-term	Similar to but greater than CP1 and less than CP2 & CP5	B	No mitigation needed; thus, none proposed.	B
	CP4	Long-term	Similar to but greater than CP1, CP2, & CP3	B	No mitigation needed; thus, none proposed.	B
	CP44	Long-term	Similar to but greater than CP1, CP2, & CP3, but less than CP4	B	No mitigation needed; thus, none proposed.	B
Impact Rec-10 (CP1–CP5): Disruption of Sacramento River Boating and Access Resulting from the Gravel Augmentation Program	N-A	NA	–	NI	NA	NI
	CP1–CP3	Short-term	–	NI	No mitigation needed; thus, none proposed.	NI
	CP4–CP5	Short-term	Potential disruption during a 1-month period	LTS	No mitigation needed; thus, none proposed.	LTS

Notes:

[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.

[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.

[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.

[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.

[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Rec-11 (CP1–CP5): Changes in Usability of Reading Island Fishing Access Boat Ramp and Enhanced Recreation at Upper Sacramento River Restoration Sites	N-A	NA	–	NI	NA	NI
	CP1–CP3	Long-term	–	NI	No mitigation needed; thus, none proposed.	NI
	CP4–CP5	Long-term	–	B	No mitigation needed; thus, none proposed.	B
Impact Rec-12 (CP1–CP5): Seasonal Inundation of Portions of River Recreation Facilities or Informal River Access Sites on the Lower Sacramento River and Rivers Below CVP and SWP Reservoirs as a Result of Increased River Flows	N-A	NA	–	NI	NA	NI
	CP1 & CP4	Long-term	Flows would increase but would remain below winter and spring high flows experienced in most years –	LTS	No mitigation needed; thus, none proposed.	LTS
	CP2 & CP4A	Long-term	Similar to CP1, but greater	LTS	No mitigation needed; thus, none proposed.	LTS
	CP3	Long-term	Similar to CP1 & CP2, but greater	LTS	No mitigation needed; thus, none proposed.	LTS
	CP5	Long-term	Similar to CP1, CP2, & CP3, but greater	LTS	No mitigation needed; thus, none proposed.	LTS
Impact Rec-13 (CP1–CP5): Increased Difficulty for Boaters in Using the Lower Sacramento River and Rivers Below CVP and SWP Reservoirs as a Result of Increased River Flows	N-A	NA	–	NI	NA	NI
	CP1 & CP4	Long-term	Increased mean monthly flows within the extended study area	LTS	No mitigation needed; thus, none proposed.	LTS
	CP2 & CP4A	Long-term	Similar to CP1, but greater	LTS	No mitigation needed; thus, none proposed.	LTS
	CP3	Long-term	Similar to CP1 & CP2, but greater	LTS	No mitigation needed; thus, none proposed.	LTS
	CP5	Long-term	Similar to CP1, CP2, & CP3, but greater	LTS	No mitigation needed; thus, none proposed.	LTS

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Rec-14 (CP1–CP5): Increased Difficulty for Swimmers and Waders in Using the Sacramento River and Rivers Below CVP and SWP Reservoirs as a Result of Increased River Flows	N-A	NA	–	NI	NA	NI
	CP1 & CP4	Long-term	Increased mean monthly flows within the extended study area	LTS	No mitigation needed; thus, none proposed.	LTS
	CP2 & CP4A	Long-term	Similar to CP1, but greater	LTS	No mitigation needed; thus, none proposed.	LTS
	CP3	Long-term	Similar to CP1 & CP2, but greater	LTS	No mitigation needed; thus, none proposed.	LTS
	CP5	Long-term	Similar to CP1, CP2, & CP3, but greater	LTS	No mitigation needed; thus, none proposed.	LTS
Impact Rec-15 (CP1–CP5): Increased Difficulty for Boaters and Anglers in Using the Sacramento River and Rivers Below CVP and SWP Reservoirs as a Result of Decreased River Flows	N-A	NA	–	NI	NA	NI
	CP1 & CP4	Long-term	Increased mean monthly flows within the extended study area	PS	Mitigation Measure Rec-15: Implement Mitigation Measure Aqua-15: Maintain Flows in the Feather River, American River, and Trinity River Consistent with Existing Regulatory and Operational Requirements and Agreements.	LTS
	CP2 & CP4A	Long-term	Similar to but potentially greater than CP1	PS	Mitigation Measure Rec-15: Implement Mitigation Measure Aqua-15: Maintain Flows in the Feather River, American River, and Trinity River Consistent with Existing Regulatory and Operational Requirements and Agreements.	LTS

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Rec-15 (CP1–CP5): Increased Difficulty for Boaters and Anglers in Using the Sacramento River and Rivers Below CVP and SWP Reservoirs as a Result of Decreased River Flows (contd.)	CP3	Long-term	Similar to but potentially greater than CP1 & CP2	PS	Mitigation Measure Rec-15: Implement Mitigation Measure Aqua-15: Maintain Flows in the Feather River, American River, and Trinity River Consistent with Existing Regulatory and Operational Requirements and Agreements.	LTS
	CP5	Long-term	Similar to but potentially greater than CP1, CP2, & CP3	PS	Mitigation Measure Rec-15: Implement Mitigation Measure Aqua-15: Maintain Flows in the Feather River, American River, and Trinity River Consistent with Existing Regulatory and Operational Requirements and Agreements.	LTS
Aesthetics and Visual Resources						
Impact Vis-1: Consistency with Guidelines for Visual Resources in the STNF LRMP (Shasta Lake and Vicinity and Upper Sacramento River)	N-A	NA	–	NI	NA	NI
	CP1–CP5	Short-term and long-term	Degraded visual character and quality of primary study area	S	Mitigation Measure Vis-1: Amend the STNF LRMP to Include Revised VQOs for developments at Turntable Bay area.	SU
Impact Vis-2: Degradation and/or Obstruction of a Scenic View from Key Observation Points (Shasta Lake and Vicinity and Upper Sacramento River)	N-A	NA	–	NI	NA	NI
	CP1	Short-term	Scenic views obstructed or degraded in primary study area	S	Mitigation Measure Vis-2: Minimize Construction-Related Visual Impacts on Scenic Views From Key Observation Points.	SU
	CP2	Short-term	Similar to CP1, but greater (acres, miles, duration)	S	Mitigation Measure Vis-2: Minimize Construction-Related Visual Impacts on Scenic Views From Key Observation Points.	SU
	CP3–CP5	Short-term	Similar to CP1& CP2, but greater (acres, miles, duration)	S	Mitigation Measure Vis-2: Minimize Construction-Related Visual Impacts on Scenic Views From Key Observation Points.	SU

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Vis-3: Generation of Increased Daytime Glare and/or Nighttime Lighting (Shasta Lake and Vicinity and Upper Sacramento River)	N-A	NA	–	NI	NA	NI
	CP1	Short-term and long-term	Increased glare in primary study area	S	Mitigation Measure Vis-3: Minimize or Avoid Visual Impacts of Daytime Glare and Nighttime Lighting.	SU
	CP2	Short-term and long-term	Similar to CP1, but greater (amount, duration)	S	Mitigation Measure Vis-3: Minimize or Avoid Visual Impacts of Daytime Glare and Nighttime Lighting.	SU
	CP3–CP5	Short-term and long-term	Similar to CP1 & CP2, but greater (amount, duration)	S	Mitigation Measure Vis-3: Minimize or Avoid Visual Impacts of Daytime Glare and Nighttime Lighting.	SU
Impact Vis-4: Consistency with Federal and State Scenic Highway Requirements (Shasta Lake and Vicinity and Upper Sacramento River)	N-A	NA	–	NI	NA	NI
	CP1	Permanent	Visible from SR 151.	LTS	No mitigation needed; thus, none proposed.	LTS
	CP2	Permanent	Similar to CP1, but greater vegetation removal would be visible	LTS	No mitigation needed; thus, none proposed.	LTS
	CP3–CP5	Permanent	Similar to CP1 & CP2, but greater vegetation removal would be visible	LTS	No mitigation needed; thus, none proposed.	LTS

Notes:

1 Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.

2 NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.

3 NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.

4 LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.

5 NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Transportation and Traffic						
Impact Trans-1: Short-Term and Long-Term Increases in Traffic in the Primary Study Area in Relation to the Existing Traffic Load and Capacity of the Street System	N-A	Long-term	–	LTS	NA	LTS
	CP1	Long-term	Increase in one-way trips per day throughout the primary study area	LTS	Mitigation Measure Trans-1: Prepare and Implement a Traffic Control and Safety Assurance Plan.	LTS
		Short-term	Increase in round trips per day	PS	Mitigation Measure Trans-1: Prepare and Implement a Traffic Control and Safety Assurance Plan.	LTS
	CP2	Long-term	Similar to CP1, but greater	LTS	Mitigation Measure Trans-1: Prepare and Implement a Traffic Control and Safety Assurance Plan.	LTS
		Short-term	Similar to CP1, but over a longer period	PS	Mitigation Measure Trans-1: Prepare and Implement a Traffic Control and Safety Assurance Plan.	LTS
	CP3–CP5	Long-term	Similar to CP1 and CP2, but greater	LTS	Mitigation Measure Trans-1: Prepare and Implement a Traffic Control and Safety Assurance Plan.	LTS
		Short-term	Similar to CP1 & CP2, but over a longer period	PS	Mitigation Measure Trans-1: Prepare and Implement a Traffic Control and Safety Assurance Plan.	LTS

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Trans-2: Adverse Effects on Access to Local Streets or Adjacent Uses in the Primary Study Area	N-A	NA	–	LTS	NA	LTS
	CP1	Permanent and/or temporary	Road closures and detours or partial road closures, or a combination of both, at Shasta Lake	PS	Mitigation Measure Trans-2: To Reduce Effects on Local Access, Implement Mitigation Measure Trans-1: Prepare and Implement a Traffic Control and Safety Assurance Plan	LTS
	CP2	Permanent and/or temporary	Similar to CP1, but over a longer period	PS	Mitigation Measure Trans-2: To Reduce Effects on Local Access, Implement Mitigation Measure Trans-1: Prepare and Implement a Traffic Control and Safety Assurance Plan	LTS
	CP3–CP5	Permanent and/or temporary	Similar to CP1 and CP2, but over a longer period	PS	Mitigation Measure Trans-2: To Reduce Effects on Local Access, Implement Mitigation Measure Trans-1: Prepare and Implement a Traffic Control and Safety Assurance Plan	LTS
Impact Trans-3: Hazards in the Primary Study Area Caused by a Design Feature	N-A	NA	–	LTS	NA	LTS
	CP1	Permanent	Relocated road segments and vehicular and railroad bridges would be designed to current engineering design standards	B	No mitigation needed; thus, none proposed.	B
	CP2	Permanent	Similar to CP1, but more road segments and bridges would be replaced	B	No mitigation needed; thus, none proposed.	B
	CP3–CP5	Permanent	Similar to CP1 and CP2, but more road segments & bridges would be replaced	B	No mitigation needed; thus, none proposed.	B

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Trans-4: Adverse Effects on Emergency Access in the Primary Study Area	N-A	NA	–	LTS	NA	LTS
	CP1	Temporary	Road closures may result in increased response times for emergency vehicles	PS	Mitigation Measure Trans-4: To Reduce Effects on Emergency Access, Implement Mitigation Measure Trans-1: Prepare and Implement a Traffic Control and Safety Assurance Plan	LTS
	CP2	Temporary	Similar to CP1, but for a longer period	PS	Mitigation Measure Trans-4: To Reduce Effects on Emergency Access, Implement Mitigation Measure Trans-1: Prepare and Implement a Traffic Control and Safety Assurance Plan	LTS
	CP3	Temporary	Similar to CP1 & CP2, but for a longer period	PS	Mitigation Measure Trans-4: To Reduce Effects on Emergency Access, Implement Mitigation Measure Trans-1: Prepare and Implement a Traffic Control and Safety Assurance Plan	LTS
	CP4–CP5	Temporary	Similar to CP3, but with gravel augmentation	PS	Mitigation Measure Trans-4: To Reduce Effects on Emergency Access, Implement Mitigation Measure Trans-1: Prepare and Implement a Traffic Control and Safety Assurance Plan	LTS

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Trans-5: Accelerated Degradation of Surface Transportation Facilities in the Primary Study Area	N-A	NA	–	LTS	NA	LTS
	CP1	Permanent	Increase in round trips per day	PS	Mitigation Measure Trans-5: Identify and Repair Roadway Segments Damaged by the Project.	LTS
	CP2	Permanent	Similar to CP1, but greater	PS	Mitigation Measure Trans-5: Identify and Repair Roadway Segments Damaged by the Project.	LTS
	CP3		Similar to CP1 & CP2, but greater	PS	Mitigation Measure Trans-5: Identify and Repair Roadway Segments Damaged by the Project.	LTS
	CP4–CP5	Permanent	Similar to CP1, CP2, & CP3, but greater	PS	Mitigation Measure Trans-5: Identify and Repair Roadway Segments Damaged by the Project.	LTS
Impact Trans-6 (No-Action): Temporary Increase in Traffic in the Extended Study Area in Relation to the Existing Traffic Load and Capacity of the Street System	N-A	Temporary	–	LTS	NA	LTS
	CP1–CP5	NA	–	NA	No mitigation needed; thus, none proposed.	NA
Impact Trans-7 (No-Action): Adverse Effects on Access to Local Streets or Adjacent Uses in the Extended Study Area	N-A	Temporary	–	LTS	NA	LTS
	CP1–CP5	NA	–	NA	No mitigation needed; thus, none proposed.	NA
Impact Trans-8 (No-Action): Hazards in the Extended Study Area Caused by a Design Feature	N-A	Temporary	–	LTS	NA	LTS
	CP1–CP5	NA	–	NA	No mitigation needed; thus, none proposed.	NA

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Trans-9 (No-Action): Adverse Effects on Emergency Access in the Extended Study Area	N-A	Temporary	–	LTS	NA	LTS
	CP1–CP5	NA	–	NA	No mitigation needed; thus, none proposed.	NA
Impact Trans-10 (No-Action): Accelerated Degradation of Surface Transportation Facilities in the Extended Study Area	N-A	Temporary	–	LTS	NA	LTS
	CP1–CP5	NA	–	NA	No mitigation needed; thus, none proposed.	NA
Utilities and Service Systems						
Impact Util-1: Damage to or Disruption of Public Utility and Service Systems Infrastructure (Shasta Lake and Vicinity and Upper Sacramento River)	N-A	NA	–	NI	NA	NI
	CP1	Short-term	Abandon & relocate 31,000 feet of power lines, 33,000 feet of telecommunications lines	PS	Mitigation Measure Util-1: Implement Procedures to Avoid Damage to or Temporary Disruption of Service.	LTS
	CP2	Short-term	Abandon & relocate 36,000 feet of power lines, 36,000 feet of telecommunications lines	PS	Mitigation Measure Util-1: Implement Procedures to Avoid Damage to or Temporary Disruption of Service.	LTS
	CP3–CP5	Short-term	Abandon & relocate 39,000 feet of power lines, 39,000 feet of telecommunications lines	PS	Mitigation Measure Util-1: Implement Procedures to Avoid Damage to or Temporary Disruption of Service.	LTS

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Util-2: Utility Infrastructure Relocation or Modification (Shasta Lake and Vicinity and Upper Sacramento River)	N-A	NA	–	NI	NA	NI
	CP1	Short-term	Abandon & relocate 31,000 feet of power lines, 33,000 feet of telecommunications lines	PS	Mitigation Measure Util-2: Adopt Measures to Minimize Infrastructure Relocation Impacts.	LTS
	CP2	Short-term	Abandon & relocate 36,000 feet of power lines, 36,000 feet of telecommunications lines	PS	Mitigation Measure Util-2: Adopt Measures to Minimize Infrastructure Relocation Impacts.	LTS
	CP3–CP5	Short-term	Abandon & relocate 39,000 feet of power lines, 39,000 feet of telecommunications lines	PS	Mitigation Measure Util-2: Adopt Measures to Minimize Infrastructure Relocation Impacts.	LTS
Impact Util-3: Short-Term Increase in Solid Waste Generation (Shasta Lake and Vicinity and Upper Sacramento River)	N-A	NA	–	NI	NA	NI
	CP1	Short-term	176,627 cubic yards of solid waste	LTS	No mitigation needed; thus, none proposed.	LTS
	CP2	Short-term	188,584 cubic yards of solid waste	LTS	No mitigation needed; thus, none proposed.	LTS
	CP3	Short-term	219,889 cubic yards of solid waste	LTS	No mitigation needed; thus, none proposed.	LTS
	CP4 & CP4A	Short-term	Similar to CP3 but slight increase in solid waste generation	LTS	No mitigation needed; thus, none proposed.	LTS
	CP5	Short-term	Similar to CP4 but slight increase in solid waste generation	LTS	No mitigation needed; thus, none proposed.	LTS

Notes:

1 Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.

2 NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.

3 NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.

4 LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.

5 NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Util-4: Increases in Solid Waste Generation from Increased Recreational Opportunities (Shasta Lake and Vicinity and Upper Sacramento River)	N-A	NA	–	NI	NA	NI
	CP1	Long-term	Increase in solid waste generated by recreationists	LTS	No mitigation needed; thus, none proposed.	LTS
	CP2	Long-term	Similar to CP1 but greater	LTS	No mitigation needed; thus, none proposed.	LTS
	CP3–CP5	Long-term	Similar to but greater than CP1 & CP2	LTS	No mitigation needed; thus, none proposed.	LTS
Impact Util-5: Increased Demand for Water Treatment and Distribution Facilities Resulting from Increases in Water Supply (Shasta Lake and Vicinity and Upper Sacramento River)	N-A	NA	–	NI	NA	NI
	CP1–CP5	Long-term	–	TS	No mitigation needed; thus, none proposed.	TS
Impact Util-6: Damage to or Disruption of Public Utility and Service Systems Infrastructure (Lower Sacramento River, Delta, CVP/SWP Service Areas)	N-A	NA	–	NA	NA	NA
	CP1–CP3	Short-term	–	NI	No mitigation needed; thus, none proposed.	NI
Impact Util-7: Utility Infrastructure Relocation or Modification (Lower Sacramento River, Delta, CVP/SWP Service Areas)	N-A	NA	–	NA	NA	NA
	CP1–CP5	Short-term	–	NI	No mitigation needed; thus, none proposed.	NI

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable. TS = too speculative for meaningful consideration.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Util-8: Short-Term Increase in Solid Waste Generation (Lower Sacramento River, Delta, CVP/SWP Service Areas)	N-A	NA	–	NA	NA	NA
	CP1–CP3	Short-term	–	NI	No mitigation needed; thus, none proposed.	NI
	CP4–CP5	Short-term	–	LTS	No mitigation needed; thus, none proposed.	LTS
Impact Util-9: Increases in Solid Waste Generation from Increased Recreational Opportunities (Lower Sacramento River, Delta, CVP/SWP Service Areas)	N-A	NA	–	NA	NA	NA
	CP1–CP5	Long-term	–	NI	No mitigation needed; thus, none proposed.	NI
Impact Util-10: Increased Demand for Water Treatment and Distribution Facilities Resulting from Increases in Water Supply (Lower Sacramento River, Delta, CVP/SWP Service Areas)	N-A	NA	–	NA	NA	NA
	CP1–CP5	Long-term	NA	TS	No mitigation needed; thus, none proposed.	TS

Notes:

[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.

[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.

[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.

[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable. TS = too speculative for meaningful consideration.

[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Public Services						
Impact PS-1: Disruption of Public Services(Shasta Lake and Vicinity and Upper Sacramento River)	N-A	NA	–	NI	NA	NI
	CP1	Short-term	Risk of service disruption during construction	PS	Mitigation Measure PS-1: Coordinate and Assist Public Services Agencies.	LTS
	CP2	Short-term	Similar to CP1, but greater construction duration & area	PS	Mitigation Measure PS-1: Coordinate and Assist Public Services Agencies.	LTS
	CP3–CP5	Short-term	Similar to CP1 & CP2, but greater construction duration & area	PS	Mitigation Measure PS-1: Coordinate and Assist Public Services Agencies.	LTS
Impact PS-2: Degraded Level of Public Services (Shasta Lake and Vicinity and Upper Sacramento River)	N-A	NA	–	NI	NA	NI
	CP1	Short-term	– Risk of degraded level of public services during construction	PS	Mitigation Measure PS-2: Provide Support to Public Services Agencies.	LTS
	CP2	Short-term	Similar to CP1, but greater construction duration	PS	Mitigation Measure PS-2: Provide Support to Public Services Agencies.	LTS
	CP3–CP5	Short-term	Similar to CP1 & CP2, but greater construction duration	PS	Mitigation Measure PS-2: Provide Support to Public Services Agencies.	LTS
Impact PS-3: Relocation of Public Service Facilities (Shasta Lake and Vicinity and Upper Sacramento River)	N-A	NA	–	NI	NA	NI
	CP1	Long-term	–	LTS	No mitigation needed; thus, none proposed.	LTS
	CP2	Long-term	Greater than CP1	LTS	No mitigation needed; thus, none proposed.	LTS
	CP3–CP5	Long-term	Greater than CP1 & CP2	LTS	No mitigation needed; thus, none proposed.	LTS

Notes:
1 Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
2 NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
3 NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
4 LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
5 NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact PS-4: Short-Term Disruption of Public Services (Lower Sacramento River, Delta, CVP/SWP Service Areas)	N-A	NA	–	NI	NA	NI
	CP1–CP5	Short-term	–	NI	No mitigation needed; thus, none proposed.	NI
Impact PS-5: Degraded Levels of Public Services (Lower Sacramento River, Delta, CVP/SWP Service Areas)	N-A	NA	–	NI	NA	NI
	CP1–CP5	Short-term	–	LTS	No mitigation needed; thus, none proposed.	LTS
Impact PS-6: Relocation of Public Services Facilities (Lower Sacramento River, Delta, CVP/SWP Service Areas)	N-A	NA	–	NI	NA	NI
	CP1–CP5	Long-term	–	NI	No mitigation needed; thus, none proposed.	NI
Power and Energy						
Impact Hydro-1: Decrease in Shasta Powerplant Energy Generation	N-A,	Long-term	Increase in Shasta Powerplant energy generation	B	NA	B
	CP1–CP5	Long-term	Increase in Shasta Powerplant energy generation	B	No mitigation needed; thus, none proposed.	B
Impact Hydro-2: Decrease in CVP System Energy Generation	N-A,	Long-term	Decrease in energy generation of <1%	LTS	NA	LTS
	CP1–CP5	Long-term	<5% decrease in CVP system energy generation	B	No mitigation needed; thus, none proposed.	B

Notes:

[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.

[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.

[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.

[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.

[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact Hydro-3: Decrease in SWP System Energy Generation	N-A,	Long-term	Increase in SWP system energy generation	B	NA	B
	CP1, CP2, CP4 – CP5	Long-term	Increase in SWP system energy generation	B	No mitigation needed; thus, none proposed.	B
	CP3	Long-term	<5% decrease in SWP system energy generation	LTS	No mitigation needed; thus, none proposed.	LTS
Impact Hydro-4: Increase in CVP System Pumping Energy Use	N-A,	Long-term	<5% increase in CVP energy system pumping energy use	LTS	NA	LTS
	CP1–CP5	Long-term	<5% increase in CVP energy system pumping energy use	LTS	No mitigation needed; thus, none proposed.	LTS
Impact Hydro-5: Increase in SWP System Pumping Energy Use	N-A	Long-term	<5% increase in SWP energy system pumping energy use	LTS	NA	LTS
	CP1–CP5	Long-term	<5% increase in SWP energy system pumping energy use	LTS	No mitigation needed; thus, none proposed.	LTS
Impact Hydro-6: Decrease in Pit 7 Powerplant Energy Generation	N-A	Long-term	<5% decrease in Pit 7 Powerplant energy generation	NI	NA	NI
	CP1–CP5	Long-term	<5% decrease in Pit 7 Powerplant energy generation	LTS	No mitigation needed; thus, none proposed.	LTS

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Environmental Justice						
Impact EJ-1: Potential Disproportionate High and Adverse Effect on Minority and Low-Income Populations in the Vicinity of Shasta Lake	N-A	NA	–	NDHA	NA	NDHA
	CP1–CP5	Short-term	–	NDHA	No mitigation needed; thus, none proposed.	NDHA
Impact EJ-2: Potential Disproportionate High and Adverse Effect on Native American Populations from Disturbance or Loss of Sacred Locations in the Vicinity of Shasta Lake	N-A	NA	–	NDHA	NA	NDHA
	CP1–CP5	Short-term and long-term	–	DHA	No feasible mitigation is available to reduce impact.	DHA
Impact EJ-3: Potential Disproportionate High and Adverse Effect on Minority and Low-Income Populations in the Upper Sacramento River Area	N-A	Long-term	–	NDHA	NA	NDHA
	CP1–CP5	Long-term	–	NDHA	No mitigation needed; thus, none proposed.	NDHA
Impact EJ-4: Potential Disproportionate High and Adverse Effect on Minority and Low-Income Populations in the Lower Sacramento River and Delta Area	N-A	NA	–	NDHA	NA	NDHA
	CP1–CP5	Long-term	–	NDHA	No mitigation needed; thus, none proposed.	NDHA
Impact EJ-5: Potential Disproportionate High and Adverse Effect on Minority and Low-Income Populations in the CVP/SWP Service Areas	N-A	NA	–	NDHA	NA	NDHA
	CP1–CP5	Long-term	–	NDHA	No mitigation needed; thus, none proposed.	NDHA

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable. NDHA = not disproportionately high and adverse. DHA = disproportionately high and adverse.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Wild and Scenic River Considerations for McCloud River						
Impact WASR-1: McCloud River's Eligibility for Listing as a Federal Wild and Scenic River	N-A	NA	–	NI	NA	NI
	CP1	Permanent	11 percent of Segment 4 would be periodically inundated	S	No feasible mitigation available to reduce impact.	SU
	CP2	Permanent	21 percent of Segment 4 would be periodically inundated	S	No feasible mitigation available to reduce impact.	SU
	CP3–CP5	Permanent	39 percent increase over the current transition reach), inundating larger portion of the lower McCloud River and Segment 4	S	No feasible mitigation available to reduce impact.	SU
Impact WASR-2: Conflict with Shasta-Trinity National Forest, Land and Resource Management Plan	N-A	NA	–	NI	NA	NI
	CP1–CP5	Permanent	–	NI	No mitigation needed; thus, none proposed.	NI

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable. TS = too speculative for meaningful consideration. NDHA = not disproportionately high and adverse. DHA = disproportionately high and adverse.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact WASR-3: Effects to McCloud River Wild Trout Fishery, as Identified in the California Public Resources Code, Section 5093.542	N-A	NA	–	NI	NA	NI
	CP1	Long-term	Increased inundation could affect the wild trout fishery (access and ecology) of the lower McCloud River identified in the State Public Resources Code.	PS	Mitigation Measure WASR-3 (CP1-CP5): Develop and Implement a Comprehensive Multi-scale Fishery Protection, Restoration and Improvement Program for the Lower McCloud River Watershed.	PS
	CP2	Long-term	Similar to CP1, but greater inundation.	PS	Mitigation Measure WASR-3 (CP1-CP5): Develop and Implement a Comprehensive Multi-scale Fishery Protection, Restoration and Improvement Program for the Lower McCloud River Watershed.	PS
	CP3–CP5	Long-term	Similar to CP1 and CP2, but greater inundation.	PS	Mitigation Measure WASR-3 (CP1-CP5): Develop and Implement a Comprehensive Multi-scale Fishery Protection, Restoration and Improvement Program for the Lower McCloud River Watershed.	PS

Notes:
[1] Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
[2] NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
[3] NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
[4] LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable. TS = too speculative for meaningful consideration. NDHA = not disproportionately high and adverse. DHA = disproportionately high and adverse.
[5] NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Table S-3. Summary of Impacts and Mitigation Measures (contd.)

Resource Topic/Impact	Alt[1]	Impact Duration[2]	Quantification/ Relative Magnitude of Impact[3]	LOS Before Mitigation[4]	Mitigation Measure[5]	LOS After Mitigation[4]
Impact WASR-4: Effects to McCloud River Free-Flowing Conditions, as Identified in the California Public Resources Code, Section 5093.542	N-A	NA	–	NI	NA	NI
	CP1	Long-term	Increased inundation could affect the free-flowing conditions of the McCloud River, as identified in the State Public Resources Code.	S	Mitigation Measure WASR-4: Develop and Implement Protection, Restoration, and Improvement Measures to Benefit Hydrologic Functions Within the Lower McCloud River Watershed	SU
	CP2	Long-term	Similar to CP1, but greater inundation.	S	Mitigation Measure WASR-4: Develop and Implement Protection, Restoration, and Improvement Measures to Benefit Hydrologic Functions Within the Lower McCloud River Watershed	SU
	CP3–CP5	Long-term	Similar to CP1 and CP2, but greater inundation.	S	Mitigation Measure WASR-4: Develop and Implement Protection, Restoration, and Improvement Measures to Benefit Hydrologic Functions Within the Lower McCloud River Watershed	SU

Notes:
1 Alt = alternative. N-A = No-Action Alternative. CP = Comprehensive Plan.
2 NA = not applicable. Short-term = construction-related or persisting from one to several years. Long-term = persisting for years to decades. Permanent = effectively irreversible.
3 NA = not applicable. "–" = the least impact among the action alternatives or an impact that is comparable in type and magnitude to the least impact among the alternatives.
4 LOS = level of significance. B = beneficial. NA = not applicable. NI = no impact. LTS = less than significant. PS = potentially significant. S = significant. SU = significant and unavoidable. TS = too speculative for meaningful consideration. NDHA = not disproportionately high and adverse. DHA = disproportionately high and adverse.
5 NA = not applicable, because under the No-Action Alternative, the Federal Government would not implement a plan to raise Shasta Dam, and no mitigation would be required.

Key:
BLM = U.S. Bureau of Land Management
BMP = best management practice
CDFW = California Department of Fish and Wildlife
cfs = cubic feet per second
CO = carbon monoxide
CO_2e = carbon dioxide equivalent
CP = Comprehensive Plan
CRMP = Coordinated Resources Management Plan
CRPR = California Rare Plant Rank
CVP = Central Valley Project
dBA = A-weighted decibels
Delta = Sacramento–San Joaquin Delta
GHG = greenhouse gas
ITA = Indian Trust Assets
lb = pound
L_{eq} = equivalent noise level
LRMP = Land and Resource Management Plan
MOA = Memorandum of Understanding
MSCS = Multi-Species Conservation Strategy
NHPA = National Historic Preservation Act
NO_X = oxides of nitrogen
PA = Programmatic Agreement
PM = particulate matter
PM_{10} = respirable particulate matter with an aerodynamic resistance diameter of 10 micrometers or less
$PM_{2.5}$ = respirable particulate matter with an aerodynamic resistance diameter of 2.5 micrometers or less
ROG = reactive organic gas
SR = State Route
STNF = Shasta-Trinity National Forest
SWP = State Water Project
TBD = to be determined
USFS = U.S. Forest Service
X2 = distance in kilometers from the Golden Gate Bridge to the location where salinity concentration is 2 parts per thousand

Shasta Lake Water Resources Investigation, California

Shasta Lake Water Resources Investigation, California Final Environmental Impact Statement

Prepared by:

United States Department of the Interior
Bureau of Reclamation
Mid-Pacific Region

December 2014

Contents

Tables

Figures

Appendices

Abbreviations and Acronyms

°F	degrees Fahrenheit
µS/cm	microSiemens per centimeter
µg/L	micrograms per liter
$\mu g/m^3$	micrograms per cubic meter
2004 NMFS BO	NMFS 2004 Biological Opinion on the Long-Term CVP and SWP Operations Criteria and Plan
2004 OCAP BA	Reclamation 2004 Long-Term CVP and SWP Operations Criteria and Plan Biological Assessment
2005 USFWS BO	USFWS 2005 Reinitiation of Formal and Early Section 7 Endangered Species Consultation on the Coordinated Operations of the CVP and SWP and the Operational Criteria and Plan to Address Potential Critical Habitat Issues
2008 Long-Term Operation BA	Reclamation 2008 Biological Assessment on the Continued Long-Term Operations of the CVP and SWP
2008 USFWS BO	USFWS 2008 Formal Endangered Species Act Consultation on the Proposed Coordinated Operations of the CVP and SWP
2009 NMFS BO	NMFS 2009 Biological Opinion and Conference Opinion on the Long-Term Operations of the CVP and SWP
AB	Assembly Bill
ABA	Architectural Barriers Act
ACID	Anderson-Cottonwood Irrigation District
ADA	Americans with Disabilities Act
AF	acre-feet
AFRP	Anadromous Fish Restoration Program
AFS	anadromous fish survival
Ag	Agricultural Water Service Contractor
Alquist-Priolo Act	Alquist-Priolo Earthquake Fault Zoning Act
Alt	alternative
APA	Administrative Procedure Act
APE	area of potential effect
AQAP	Air Quality Attainment Plan
ARB	Air Resources Board
ARPA	Archaeological Resources Protection Act of 1979
Avg	average
B	beneficial
BA	Biological Assessment

BAMM	best available mitigation measure
Banks	SWP Harvey O. Banks Pumping Plant
Basin Plan	Water Quality Control Plan for the Sacramento River and San Joaquin River Basins
Bay Area	San Francisco Bay Area
Bay-Delta	San Francisco Bay/Sacramento-San Joaquin Delta
BDCP	Bay Delta Conservation Plan
BIA	U.S. Department of the Interior, Bureau of Indian Affairs
BLM	U.S. Department of the Interior, Bureau of Land Management
BLMS	BLM sensitive
BMO	Basin Management Objective
BMP	best management practice
BO	Biological Opinion
BP	before present
BRCP	Butte Regional Conservation Plan
BST	Benchmark Study Team
BVWD	Bella Vista Water District
CAA	Federal Clean Air Act
CAAA	Federal Clean Air Act Amendments of 1990
$CaCO_3$	calcium carbonate
Cal EMA	California Emergency Management Agency
Cal Fire	California Department of Forestry and Fire Protection
CalEPA	California Environmental Protection Agency
Cal/OSHA	California Occupational Safety and Health Administration
CalEEMod	California Emissions Estimator Model
CALFED	CALFED Bay-Delta Program
Cal-IPC	California Invasive Plant Council
CalSim-II	California Water Resources Simulation Model II
Caltrans	California Department of Transportation
CBC	California Building Standards Code
CBDA	California Bay-Delta Authority
CCAA	California Clean Air Act
CCCSD	Clear Creek Community Services District
CCR	California Code of Regulations
CCSD	Centerville Community Services District
CCWD	Contra Costa Water District
CD	California Delisted
CDFA	California Department of Food and Agriculture

CDFW	California Department of Fish and Wildlife (formerly known as the California Department of Fish and Game [CDFG])
CE	California Endangered
CEQ	Council on Environmental Quality
CEQA	California Environmental Quality Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CESA	California Endangered Species Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
CHP	California Highway Patrol
CMS	comprehensive mitigation strategy
CNDDB	California Natural Diversity Database
CNEL	community noise equivalent level
CNPS	California Native Plant Society
CO	combined objective
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
COA	Coordinated Operations Agreement
County	Shasta County
County	Tehama County Department of Public Works
CP	California Fully Protected
CP	Comprehensive Plan
CRMP	coordinated resource management plan
CRPR	California Rare Plant Rank
CSA	community service area
CSAMP	Collaborative Science and Adaptive Management Process
CSC	California Species of Special Concern
CT	California Threatened
CVFPP	Central Valley Flood Protection Plan
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
CVRWQCB	Central Valley Regional Water Quality Control Board
CWA	Federal Clean Water Act
CWHR	California Wildlife Habitat Relationship
CWP	cold-water pool
D-1275	State Water Board Water Rights Decision 1275

D-1379	State Water Board Water Rights Decision 1379
D-1641	State Water Board Water Right Decision 1641
dB	decibel
dBA	A-weighted decibel
dBA/DD	dBA per doubling of distance
DCC	Delta Cross Channel
DEIR	Draft Environmental Impact Report
DEIR/S	Draft Environmental Impact Report/Statement
DEIS	Draft Environmental Impact Statement
Delta	Sacramento-San Joaquin Delta
DHA	disproportionately high and adverse
diesel PM	diesel particulate matter
District Court	District Court for the Eastern District of California
DO	dissolved oxygen
DOC	California Department of Conservation
DOSS	Delta Operations for Salmonids and Sturgeon
DPS	Distinct Population Segment
Draft Feasibility Report	Shasta Lake Water Resources Investigation Draft Feasibility Report
DSC	Delta Stewardship Council
DSM2	Delta Simulation Model 2
DWR	California Department of Water Resources
E/I	export/inflow
EBMUD	East Bay Municipal Utility District
EC	electrical conductivity
EIR	Environmental Impact Report
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ERP	Ecosystem Restoration Program
ESA	Federal Endangered Species Act
Exh	exhaust
FAC	facultative plants
FACU	facultative upland plants
FACW	facultative wetland plants
FB	Federal Bald and Golden Eagle Protection Act
FC	Federal candidate for listing
FD	Federally delisted
Federal WSRA	Federal Wild and Scenic Rivers Act

FERC	Federal Energy Regulatory Commission
FLPMA	Federal Land Policy and Management Act of 1976
FMMP	Farmland Mapping and Monitoring Program
FHA	Federal Highway Administration
FP	Federally petitioned for listing
FPD	Proposed for Federal delisting
FSSC	Forest Service Site Class
FSZ	Farmland Security Zone
FT	Federally listed as threatened
FTA	Federal Transit Administration
FWCA	Fish and Wildlife Coordination Act
GAMA	Groundwater Ambient Monitoring and Assessment
General Industrial Permit	Industrial Stormwater General Permit
GHG	greenhouse gas
GIS	geographic information system
GW	Groundwater
GWh	gigawatt-hour
GWh/yr	gigawatt-hour per year
GWM	Groundwater Management
GWMP	Groundwater Management Plan
GWP	global warming potential
H&H	hydrology, hydraulics, and water management
HAP	hazardous air pollutant
HCP	Habitat Conservation Plan
HMBP	Hazardous Materials Business Plan
hp	horsepower
HVAC	heating, ventilation, and air conditioning
Hz	Hertz
I-5	Interstate 5
ICOLD	International Commission of Large Dams
ID	Irrigation District
IFIM	Instream Flow Incremental Methodology
IFPSC	Interagency Fish Passage Steering Committee
IL4	Incremental Level 4
IMPLAN	IMpact analysis for PLANning
in/sec	inches per second
Interior	U.S. Department of the Interior
IRA	Inventoried Roadless Area

ITA	Indian Trust Assets
ITE	Institute of Transportation Engineers
Jones	CVP C.W. “Bill” Jones Pumping Plant
JPOD	joint points of diversion
KCSA	Keswick County Service Area
km	kilometer
KOP	key observation point
kV	kilovolts
L2	Level 2
L4	Level 4
lb	pound
lb/day	pounds per day
L_{dn}	day-night noise level
LEDPA	Least Environmentally Damaging Practicable Alternative
L_{eq}	equivalent noise level
L_{max}	maximum noise level
L_{min}	minimum noise level
LOS	level of significance
LRMP	Land and Resource Management Plan
LSR	Late Successional Reserves
LSSRP	Local Bridge Seismic Safety Retrofit Program
LSZ	low salinity zone
LTGen	LongTermGen, Version 1.18
LTS	less than significant
L_x	statistical descriptor
m	meter
M&I	municipal and industrial
MAF	million-acre feet
MBTA	Migratory Bird Treaty Act
MCV	Manual of California Vegetation
mg/L	milligrams per liter
mg/m^3	milligrams per cubic meter
MGCSD	Mountain Gate Community Services District
mgd	million gallons per day
mmhos/cm	millimhos per centimeter
MMT	million metric ton
MOA	Memorandum of Agreement
mph	miles per hour

MSCS	Multi-Species Conservation Strategy
msl	mean sea level
MT	metric ton
MW	megawatt
MWh	megawatt-hour
N	nitrogen
N-A	No-Action Alternative
N/A	not applicable
NA	not applicable
NAHC	Native American Heritage Commission
NAVD88	North American Vertical Datum of 1988
NDHS	not disproportionately high and adverse
NDOI	Net Delta Outflow Index
NED	National Economic Development
NEHRPA	National Earthquake Hazards Reduction Program Act
NEPA	National Environmental Policy Act
NFS	National Forest System
ng/L	nanograms per liter
NGVD29	National Geodetic Vertical Datum 1929
NHPA	National Historic Preservation Act
NI	no impact
NL	Not Listed
NMFS	National Marine Fisheries Service
NO_2	nitrogen dioxide
NO_2	nitrate
NO_3	nitrite
NOA	Notice of Availability
NOD	north of Delta
NOI	Notice of Intent
NO_X	oxides of nitrogen
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRA	National Recreation Area
NRCS	U.S. Natural Resources Conservation Service
NRDC	National Resources Defense Council
NRHP	National Register of Historic Places
NRI	National Rivers Inventory
NSVAB	Northern Sacramento Valley Air Basin

ntu	nephelometric turbidity units
NWFP	Northwest Forest Plan
NWP	Nationwide Permit
OBL	obligate wetland plants
OCAP	Operations Criteria and Plan
OES	Governor's Office of Emergency Services
OHV	Off-Highway Vehicle
OMR	Old and Middle River
OPR	Governor's Office of Planning and Research
Oroville Facilities	Edward Hyatt Pumping-Generating Plant, Thermalito Diversion Dam Powerplant, and Thermalito Pumping-Generating Plant
ORV	outstandingly remarkable value
OSHA	Occupational Safety and Health Administration
P	phosphorus
P&G	Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies
PA	programmatic agreement
PCB	polychlorinated biphenyl
PCT	Project Coordination Team
PEIS/R	Programmatic Environmental Impact Statement/Environmental Impact Report
PG&E	Pacific Gas and Electric Company
PLSS	Public Land Survey System
PM	particulate matter
PM_{10}	respirable particulate matter with an aerodynamic resistance diameter of 10 micrometers or less
$PM_{2.5}$	fine particulate matter with an aerodynamic resistance diameter of 2.5 micrometers or less
PMF	probable maximum flood
Porter-Cologne Act	Porter-Cologne Water Quality Control Act
ppm	parts per million
PPV	peak particle velocity
PRC	Public Resources Code
PS	potentially significant
PSD	New Source Review Prevention of Significant Deterioration
PUD	Public Utilities District
RABA	Redding Area Bus Authority
RAP	Road Analysis Process

RBPP	Red Bluff Pumping Plant
RCD	resource conservation district
RCRA	Resource Conservation and Recovery Act
RD-1641	State Water Board Revised Water Right Decision 1641
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
Recovery Plan	NMFS 2014 Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-run Chinook Salmon and Central Valley Spring-run Chinook Salmon and the Distinct Population Segment of Central Valley Steelhead
Ref	refuge
Refuge	Level 2 Federal Refuge
Reporting Rule	Greenhouse Gas Reporting Rule
Resources Agency	California Natural Resources Agency (formerly known as the California Resources Agency or State Resources Agency)
RHJV	Riparian Habitat Joint Venture
RM	River Mile
RMP	Resource Management Plan
RMS	root mean squared
ROD	Record of Decision
ROG	reactive organic gas
ROS	Recreation Opportunity Spectrum
ROW	right-of-way
RPA	Reasonable and Prudent Alternative
RTS	reservoir triggered seismicity
RV	recreational vehicle
RWQCB	regional water quality control board
S	significant
S&M	Survey and Manage
SALMOD	SALMOD, Version 3.8
SB	Senate Bill
SCAQMD	Shasta County Air Quality Management District
SCC	Shasta County Code
SCFD	Shasta County Fire Department
SCSD	Shasta Community Services District
SCSO	Shasta County Sheriff’s Department
SCSO	Shasta County Sheriff’s Office
SCWA	Shasta County Water Agency

SDWA	Safe Drinking Water Act
SEL	single-event (impulsive) noise level
Settlement	Stipulation of Settlement in *NRDC, et al., v. Kirk Rodgers, et al.*
SHPO	State Historic Preservation Officer
SIP	State implementation plan
SJRRP	San Joaquin River Restoration Program
SLC	State Lands Commission
SLFPD	Shasta Lake Fire Protection District
SLWRI	Shasta Lake Water Resources Investigation
SMAQMD	Sacramento Metropolitan Air Quality Management District
SMARA	California Surface Mining and Reclamation Act of 1975
SMM	standard mitigation measure
SO_2	sulfur dioxide
SOD	south of Delta
SR	State Route
SRA	shaded riverine aquatic
SRCA	Sacramento River Conservation Area
SRNWR	Sacramento River National Wildlife Refuge
SRTTG	Sacramento River Temperature Task Group
SRWRS	Sacramento River Water Reliability Study
SSI	sediment source inventory
SSLE	Security, Safety and Law Enforcement
State	State of California
State Parks	California Department of Parks and Recreation
State Water Board	State Water Resources Control Board
STATSGO	State Soil Geographic Database
STNF	Shasta-Trinity National Forest
STNF LRMP	Shasta-Trinity National Forest Land and Resource Management Plan
SU	significant and unavoidable
SVAB	Sacramento Valley Air Basin
SVI	Sacramento Valley Index
SWAP	Statewide Agriculture Production
SWP	State Water Project
SWP Power	State Water Project Power, BST April 2010 Version
SWPPP	Stormwater Pollution Prevention Plan
TAC	toxic air contaminants
TAF	thousand acre-feet

TBD	to be determined
TCD	temperature control device
TCFD	Tehama County Fire Department
TCP	Traditional Cultural Properties
TDS	total dissolved solids
Thermal Plan	Water Quality Control Plan for the Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California
TMDL	total maximum daily load
TNC	The Nature Conservancy
TS	too speculative for meaningful consideration
UC	University of California
Uniform Act	Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended
UPRR	Union Pacific Railroad
URBEMIS	2007 Urban Emissions model
USACE	U.S. Army Corps of Engineers
USC	United States Code
USFS	U.S. Department of Agriculture, Forest Service
USFS E	USFS Endemic Species
USFS M	USFS Survey and Manage Species
USFS S	USFS Sensitive Species
USFWS	U.S. Department of the Interior, Fish and Wildlife Service
USGS	U.S. Geological Survey
VAMP	Vernalis Adaptive Management Plan
VAU	visual assessment unit
VdB	vibration decibel
VOC	volatile organic compound
VQO	visual quality objective
VRM	Visual Resource Management
WCD	Water Conservation District
WD	Water District
WDR	waste discharge requirements
WEPP	Watershed Erosion Prediction Project
Western	Western Area Power Administration
WOMT	Water Operations Management Team
WQCP	Water Quality Control Plan
WRIMS	Water Resources Integrated Modeling System
WSEL	water surface elevation

WSR	water supply reliability
WUI	wildland-urban interface
WWTP	Wastewater Treatment Plant
X2	2 parts per thousand isohaline

This page left blank intentionally.

Chapter 1 Introduction

This Environmental Impact Statement (EIS) has been prepared as part of the Shasta Lake Water Resources Investigation (SLWRI) to evaluate the potential physical, biological, cultural, and socioeconomic effects of implementing alternatives to modify the existing Shasta Dam and Reservoir, including taking no action. The SLWRI is led by the U.S. Department of the Interior, Bureau of Reclamation (Reclamation), Mid-Pacific Region.

Reclamation is serving as the Federal lead agency for compliance with the National Environmental Policy Act (NEPA). Under NEPA, a cooperating agency is any agency, other than the lead agency, that has jurisdiction by law or special expertise with respect to any environmental impact involved in an action requiring an EIS. Cooperating agencies pursuant to NEPA include the U.S. Department of Agriculture, Forest Service (USFS); Colusa Indian Community Council of the Cachil Dehe Band of Wintun Indians; U.S. Army Corps of Engineers (USACE); and U.S. Department of the Interior, Bureau of Indian Affairs (BIA). This document has also been prepared in consideration of California Environmental Quality Act (CEQA) requirements and could be used by State of California (State) permitting agencies that would be involved in reviewing and approving the project.

Reclamation completed the Draft *SLWRI Feasibility Report* (Draft Feasibility Report), Preliminary Draft EIS (Preliminary DEIS), and related appendices in November 2011. These documents were released to the public in February 2012 to present potential impacts, costs, and benefits of the action alternatives that had been evaluated at that time; to share information generated since the completion of the SLWRI Plan Formulation Report in December 2007; and to provide an additional opportunity for public and stakeholder input.

After the release of the Draft Feasibility Report and Preliminary DEIS, SLWRI alternatives were refined for the Draft EIS (DEIS) based on several factors, including updates to Central Valley Project (CVP) and State Water Project (SWP) water operations, and stakeholder input. Water operations modeling and related evaluations for the DEIS and this Final EIS reflect the following:

- The 2008 Biological Assessment on the Continued Long-Term Operations of the CVP and SWP (2008 Long-Term Operation Biological Assessment (BA)) (Reclamation 2008a)

- The U.S. Department of the Interior, Fish and Wildlife Service (USFWS) 2008 *Formal Endangered Species Act Consultation on the*

Proposed Coordinated Operations of the CVP and SWP (2008 USFWS Biological Opinion (BO)) (USFWS 2008)

- The National Marine Fisheries Service (NMFS) 2009 *BO and Conference Opinion on the Long-Term Operations of the CVP and SWP* (2009 NMFS BO) (NMFS 2009)

- Additional changes in CVP and SWP facilities and operations, such as implementation of the San Joaquin River Restoration Program

- Additional changes in non-CVP/SWP facilities and operations, such as the addition of the Freeport Regional Water Project

Reclamation released the DEIS for public review and comment in June 2013. During the process of addressing public comments on the DEIS, some notable content changes were made to the Final EIS, including:

- Refinement of the project purpose statement

- Clarification of the relationship of this EIS and tiering to the CALFED Bay-Delta Program (CALFED) Programmatic Environmental Impact Statement/Environmental Impact Report (PEIS/R)

- Refinement of the operational scenarios focused on anadromous fish survival, and the development, evaluation, and incorporation of Comprehensive Plan 4A (CP4A) Refinement of facility plans for recreation relocations, Shasta Dam modifications, Pit 7 Dam and Powerhouse modifications, and other reservoir area relocations (e.g., power transmission lines)

- Incorporation of updated resource information related to physical and biological resources in the primary study area

- Based on facility and construction footprints, refinement of "maximum" affected areas and refinement of "most likely" affected areas for biological resources

- In conjunction with an interagency, interdisciplinary team, refinement and enhancement of the mitigation measures, including development of a framework to quantify impacts (where appropriate) and establish mitigation ratios that are applicable to a number of impacts related to biological resources

1.1 Background

Reclamation was established in 1902 to help meet the increasing water demands of the West. Today, Reclamation is the largest water provider in the country and the second largest producer of hydroelectric power in the western United States. Reclamation's Mid-Pacific Region is responsible for managing the CVP, which stores and delivers about 20 percent of California's developed water—7 million acre-feet (MAF)—to more than 250 water contractors throughout California.

Shasta Dam and Reservoir were constructed between September 1938 and June 1945. Water storage in Shasta Reservoir began in December 1943, and Shasta Dam was fully operable in April 1949. Reclamation operates Shasta Dam and Reservoir in conjunction with other facilities to provide for the management of floodwater, irrigation water supply, municipal and industrial (M&I) water supply, hydropower generation, and maintenance of navigation flows. The Central Valley Project Improvement Act (CVPIA) added "fish and wildlife mitigation, protection, and restoration" as a Reclamation priority equal to water supply and "fish and wildlife enhancement" as a priority equal to hydropower generation.

Shasta Dam and Reservoir are integral elements of the CVP, with Shasta Reservoir representing about 41 percent of the total reservoir storage capacity of the CVP. The 602-foot-tall Shasta Dam (533 feet above the streambed) and 4.55-MAF Shasta Reservoir are located on the upper Sacramento River in northern California, north of the City of Redding (see Figure 1-1) and within the Whiskeytown-Shasta-Trinity National Recreation Area (NRA). Shasta Lake supports extensive water-oriented recreation. Recreation in this area is managed by the USFS. Shasta Reservoir and Shasta Lake are used interchangeably within this EIS. Generally, however, Shasta Reservoir is used in references related to water operations for water supply, flood control, and environmental and related regulatory requirements (e.g., operations of the reservoir). In addition, Shasta Reservoir is often used in discussions related to broader CVP and SWP operations or facilities. Members of the public often refer to both the reservoir and its location as Shasta Lake.

In 2000, as a result of increasing demands for water supplies and growing concerns over declines in ecosystem resources in California's Central Valley, Reclamation reinitiated a feasibility investigation to evaluate the potential for enlarging Shasta Dam and Reservoir. In conducting the SLWRI, including preparing multiple SLWRI planning documents, Reclamation determined that expanding the capacity of Shasta Reservoir by modifying Shasta Dam could (1) increase survival of anadromous fish in the Sacramento River, and (2) improve water supply reliability for agricultural, M&I, and environmental water users; these are the two primary purposes of the SLWRI. In addition, implementing the proposed action would address other related resource needs.

Figure 1-1. Location of Shasta Dam and Reservoir

1.1.1 Study Authorization

Public Law 96-375 (October 3, 1980) provides the authority for conducting a feasibility study for the SLWRI. It allows the Secretary of the Interior to:

> *(a)…engage in feasibility studies relating to enlarging Shasta Dam and Reservoir, Central Valley Project, California or to the construction of a larger dam on the Sacramento River, California, to replace the present structure.*
>
> *(b) The Secretary of the Interior is further authorized to engage in feasibility studies for the purpose of determining the potential costs, benefits, environmental impacts, and feasibility of using the Sacramento River for conveying water from the enlarged Shasta Dam and Reservoir or the larger dam to points of use downstream from the dam.*

Section 103(c), "Authorizations for Federal Activities under Applicable Law," of the CALFED Bay-Delta Authorization Act (Public Law 108-361, October 25, 2004), authorizes the Secretary of the Interior to carry out the activities described in paragraphs (1) through (10) of Subsection (d), which include:

> *...(1)(A)(i) planning and feasibility studies for projects to be pursued with project-specific study for enlargement of (1) the Shasta Dam in Shasta County.*

Also, Section 103(a)(1) of Public Law 108-361 (October 25, 2004) states:

> *The Record of Decision is approved as a general framework for addressing the CALFED Bay-Delta Program, including its components relating to water storage, ecosystem restoration, water supply reliability (including new firm yield), conveyance, water use efficiency, water quality, water transfers, watersheds, the Environmental Water Account, levee stability, governance, and science.*

The CALFED Programmatic Record of Decision (ROD) (CALFED 2000a) called for the Secretary of the Interior to conduct feasibility studies for expanding CVP storage in Shasta Lake to:

> *…increase the pool of cold water available to maintain lower Sacramento River temperatures needed by certain fish and provide other water management benefits, such as water supply reliability.*

Other Federal legislation influences the SLWRI. Two laws of special note are Public Law 89-336 (November 8, 1965) and Public Law 102-575 (October 30, 1992). Public Law 89-336 created the Whiskeytown-Shasta-Trinity NRA, which includes Shasta Dam and Reservoir. Public Law 102-575, the CVPIA, directed numerous changes to CVP operations. Among these changes was adding "fish and wildlife protection, restoration, and enhancement" as a project purpose, which would result in substantial changes to water supply deliveries, river flows, and related environmental conditions in the primary and extended study areas. To minimize impacts to CVP water contractors, the CVPIA also directed the Secretary of the Interior to develop a least-cost plan to increase water supplies for CVP deliveries by the amount dedicated to fish and wildlife purposes.

1.1.2 Major Previous Studies and Reports

Major previous Reclamation studies and reports investigating potential enlargement of Shasta Dam and Reservoir include *Enlarged Shasta Lake Investigation Preliminary Findings Report* (1983); *Shasta Dam and Reservoir Enlargement: Appraisal Assessment of the Potential for Enlarging Shasta Dam and Reservoir* (1999a); *SLWRI Strategic Agency and Public Involvement Plan* (2003b); *SLWRI Mission Statement Milestone Report* (2003a); *SLWRI Initial Alternatives Information Report* (2004); *SLWRI Environmental Scoping Report* (2006); and *SLWRI Plan Formulation Report* (2007).

As described above, Reclamation completed the Preliminary DEIS, Draft Feasibility Report, and supporting technical appendices for the SLWRI in November 2011. These documents were released to the public in February 2012. Reclamation completed the DEIS and supporting technical appendices for the SLWRI in June 2013 and released the documents to the public in the same month.

1.2 Purpose and Need/Project Objectives

NEPA regulations require a statement of “the underlying purpose and need to which the agency is responding in proposing the alternatives, including the proposed action” (Title 40, Code of Federal Regulations (CFR) Part 1502.13). In California, the State CEQA Guidelines require a clearly written statement of objectives, including the underlying purpose of a proposed project (Title 14, California Code of Regulations (CCR) Section 15124(b)).

1.2.1 Project Purpose and Objectives

Project Purpose

The purpose of the proposed action is to improve operational flexibility of the Sacramento-San Joaquin Delta (Delta) watershed system to meet specified primary and secondary project objectives.

Project Objectives

Two primary project objectives (also referred to as planning objectives) and five secondary project objectives were developed for the SLWRI:

Primary Project Objectives

- Increase the survival of anadromous fish populations in the Sacramento River, primarily upstream from the Red Bluff Pumping Plant (RBPP)
- Increase water supply and water supply reliability for agricultural, M&I, and environmental purposes to help meet current and future water demands, with a focus on enlarging Shasta Dam and Reservoir

Secondary Project Objectives

- Conserve, restore, and enhance ecosystem resources in the Shasta Lake area and along the upper Sacramento River
- Reduce flood damage along the Sacramento River
- Develop additional hydropower generation capabilities at Shasta Dam
- Maintain and increase recreation opportunities at Shasta Lake

- Maintain or improve water quality conditions in the Sacramento River downstream from Shasta Dam and in the Delta

Primary project objectives are those which specific alternatives are formulated to address. The two primary project objectives are considered to have coequal priority, with each pursued to the maximum practicable extent without adversely affecting the other. Secondary project objectives are considered to the extent possible through pursuit of the primary project objectives.

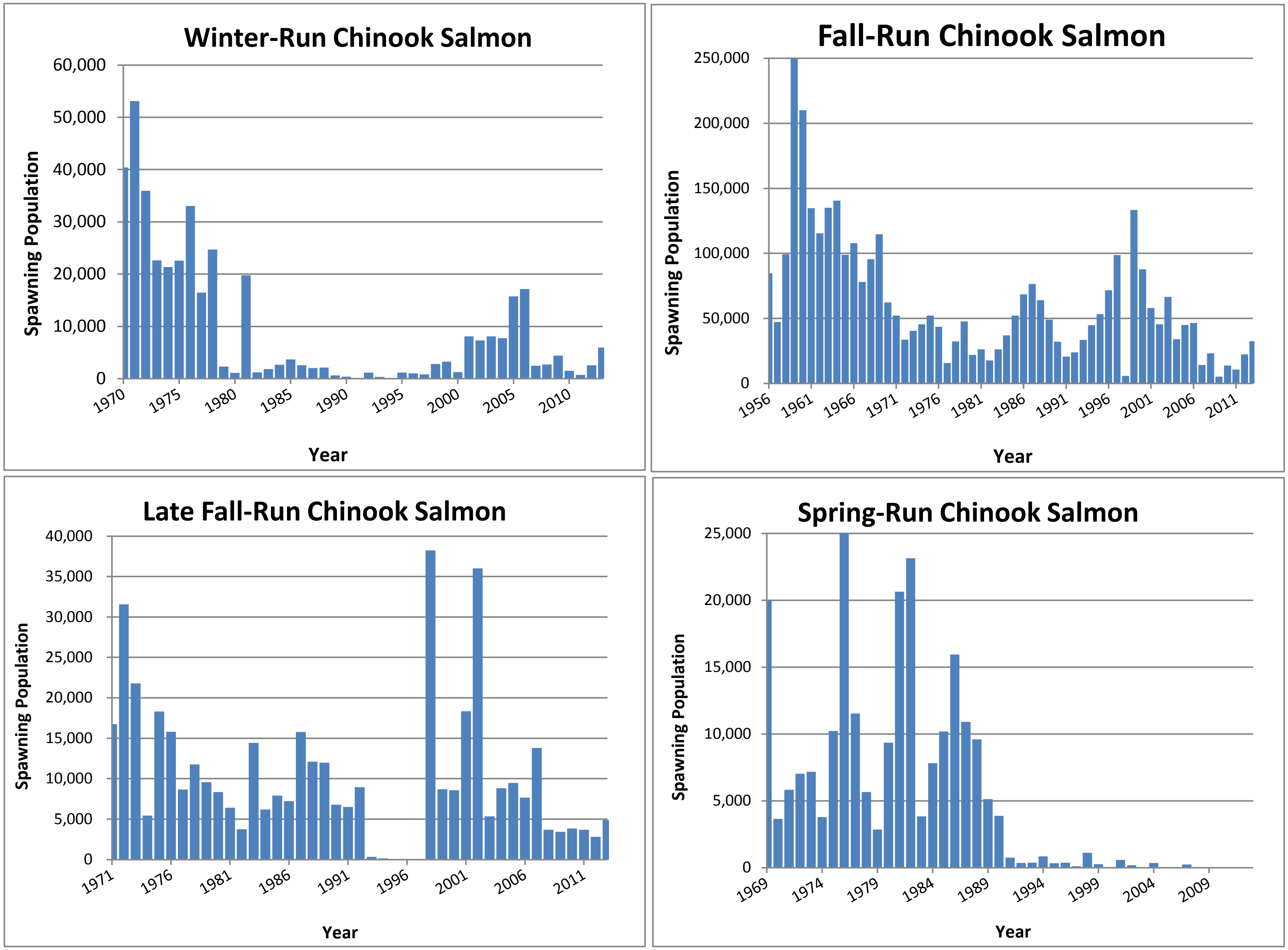
1.2.2 Project Need

Anadromous Fish Survival

The Sacramento River system supports four separate runs of Chinook salmon: fall-, late fall-, winter-, and spring-run. The adult populations of the four runs of salmon and other important fish species that spawn in the upper Sacramento River have declined considerably over the last 40 years (Figure 1-2) (CDFW 2014).

Several fish species in the upper Sacramento River have been listed as endangered or threatened under the Federal Endangered Species Act (ESA): Sacramento River winter-run Chinook salmon (endangered), Central Valley spring-run Chinook salmon (threatened), Central Valley steelhead (threatened), and the Southern Distinct Population Segment (DPS) of North American green sturgeon (threatened). Two of these species also are listed as endangered or threatened, as defined by the California Endangered Species Act (CESA): Sacramento River winter-run Chinook salmon (endangered) and Central Valley spring-run Chinook salmon (threatened).

Numerous factors have contributed to these declines. One of the most significant environmental factors affecting the number of Chinook salmon in the upper Sacramento River is unsuitable water temperature (NMFS 2014). Water temperatures that are too high or, less commonly, too low, can be detrimental to the various life stages of Chinook salmon. Elevated water temperatures can negatively affect holding and spawning adults, egg viability and incubation, preemergent fry, and rearing juveniles and smolts, substantially diminishing the next generation of returning spawners. Stress caused by high water temperatures also may reduce the resistance of fish to parasites, disease, and pollutants.



Source: CDFW 2014

Figure 1-2. Chinook Salmon Historic Spawning Populations in the Sacramento River

Releases of cold water from Shasta Reservoir can considerably improve seasonal water temperatures during critical periods for anadromous fish in the Sacramento River downstream from Shasta Dam. The *Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-run Chinook Salmon and Central Valley Spring-run Chinook Salmon and the Distinct Population Segment of Central Valley Steelhead* (Recovery Plan) (NMFS 2014) states that prolonged droughts depleting the cold-water stored in Shasta Reservoir, or some related failure to manage cold-water storage, could put populations of anadromous fish at risk of severe population decline or extirpation in the long-term (NMFS 2014). The risk associated with a prolonged drought is especially high in the Sacramento River, as Shasta Reservoir is intended to maintain only one year of carryover storage. The recovery plan emphasizes that, under current conditions, even two consecutive years of drought could reduce Shasta Reservoir storage to levels insufficient to support the Sacramento River winter-run Chinook salmon spawning and incubation season.

In May 1990, the State Water Resources Control Board (State Water Board) issued Water Right Order 90-5, which included temperature objectives for the Sacramento River to protect winter-run Chinook salmon. Three NMFS BO documents (NMFS 1993, 2004, 2009) for Sacramento River winter-run Chinook salmon reinforced this order and established certain operating parameters for Shasta Reservoir. The State Water Board action and the NMFS BOs set minimum flows in the river downstream from Keswick Dam and minimum Shasta Reservoir carryover storage targets, primarily to affect water temperatures during key periods.

In addition to changes in flow requirements, structural changes were made at Shasta Dam to change the temperature of released water, such as construction of a temperature control device (TCD), completed in 1997. The TCD can be used to selectively draw water from different depths in the lake, including the deepest, to help maintain river water temperatures beneficial to salmon. The TCD is effective in helping to reduce winter-run Chinook salmon mortality in some critical water years[1] and for fall- and spring-run Chinook salmon in below-normal water years.

With the exception of spring-run Chinook salmon, the average Chinook salmon spawning population in the Sacramento River since 1999 has increased compared with the previous 20 years (1979 to 1998) (CDFW 2014a). This increase in salmon populations is likely due primarily to minimum release requirements at Shasta Dam and the TCD. Additionally, changes in operating the Red Bluff Diversion Dam and the RBPP have benefited Chinook salmon populations in the Sacramento River. However, there is a continual need for

[1] Throughout this document, water year types are defined according to the Sacramento Valley Index Water Year Hydrologic Classification unless specified otherwise.

cool water in the Sacramento River, especially in dry and critical years, to promote anadromous fish survival and reduce the risk of extinction.

Water Supply Reliability

California's water supply system faces critical challenges with demands exceeding supplies for agricultural, M&I, and environmental water uses across the State. The California Department of Water Resources (DWR) *California Water Plan Update 2013* (DWR 2014) concludes that California is facing one of the most significant water crises in its history; drought impacts are growing, and climate change is affecting statewide hydrology. Despite significant physical improvements in water resource systems and in system management over the past few decades, California still faces unreliable water supplies, continued depletion and degradation of groundwater resources, habitat and species declines, and unacceptable risks from flooding (DWR 2014). Compounding these issues, Reclamation's *Water Supply and Yield Study* (2008b) describes dramatic increases in statewide population, land use changes, regulatory requirements, and limitations on storage and conveyance facilities, further straining available water supplies and infrastructure to meet water demands. Furthermore, projected unmet water demands are expected to increase competition for water supplies among agricultural, M&I, and environmental uses.

Estimated Water Supply Shortages Table 1-1 displays estimated water demands, available supplies, and shortages for the Central Valley and the State under existing conditions (Reclamation 2008b). Current water supply shortages for the State are estimated at 2.3 and 4.1 MAF for average and dry years, respectively. As shown in Table 1-2, without further investment in water management and infrastructure, future shortages are expected to increase to approximately 4.9 and 6.1 MAF in average and dry years, respectively, by 2030. Representative demands for dry and average years were based on water use data from the *California Water Plan Update 2005* (DWR 2005), adjusted for population growth, increasing urban water use, and reductions in irrigated acreage and environmental flow due to insufficient water supplies. Shortages were determined on a regional basis, assuming that limitations on conveyance and storage would prevent surpluses from one region or use category from filling shortages in another.

Table 1-1. Estimated Water Demands, Supplies, and Shortages Under Existing Conditions[1]

Item	Hydrologic Basin						State of California	
	Sacramento		San Joaquin		Two-Basin Total			
	Average Year[2]	Dry Year[2]	Average Year[2]	Dry Year[2]	Average Year[2]	Dry Year[2]	Average Year[2]	Dry Year[2]
Population (million)[3]	2.9		2.0		4.9		36.9	
Water Demand (MAF)								
Urban	0.9	0.9	0.6	0.6	1.5	1.5	8.9	9.0
Agricultural	8.7	8.7	7.0	7.0	15.7	15.7	34.2	34.2
Environmental	11.9	9.4	3.1	2.3	15.0	11.7	17.5	13.9
Total	***21.5***	***19.0***	***10.7***	***9.9***	***32.2***	***28.9***	***60.6***	***57.1***
Water Supply (MAF)								
Urban	0.9	0.9	0.6	0.6	1.5	1.5	8.8	8.4
Agricultural	8.7	8.6	6.9	7.0	15.6	15.6	33.2	32.0
Environmental	11.5	8.7	2.5	1.8	14.0	10.5	16.3	12.6
Total	***21.1***	***18.2***	***10.0***	***9.4***	***31.1***	***27.6***	***58.3***	***53.0***
Total Shortage (MAF)[4]	**0.4**	**0.8**	**0.7**	**0.5**	**1.1**	**1.3**	**2.3**	**4.1**

Notes:

[1] Water demands, supplies, and shortages are from the 2008 Reclamation Water Supply and Yield Study

[2] Representative dry and average year supplies and demands were based on adjusted water use and supply data from the California Water Plan Update 2005 (DWR 2005).

[3] Year 2005 population estimates are from the California Department of Finance (2010)

[4] Total shortages are calculated as the sum of shortages for each category by region (e.g., North Coast, Sacramento River) and, therefore, may not equal the difference between total demands and supplies. Shortages were determined on a regional basis, assuming that limitations on conveyance and storage would prevent surpluses from one region or use category from filling shortages in another. Detailed estimates of shortages for each region can be found in the 2008 Reclamation Water Supply and Yield Study in Table A-1 (dry year) and Table A-2 (average year). For categories where supply is greater than demand, the shortage is equal to zero.

Key:
MAF = million acre-feet

Table 1-2. Estimated Water Demands, Supplies, and Shortages for 2030[1]

Item	Sacramento and San Joaquin Hydrologic Basins		State of California	
	Two-Basin Total			
	Average Year[2]	Dry Year[2]	Average Year[2]	Dry Year[2]
Population (million)[3]	10.5		49.2	
Water Demand (MAF)				
Urban	2.4	2.5	11.9	12.0
Agricultural	15.0	15.0	31.4	31.4
Environmental	14.9	11.7	17.5	14.0
Total	***32.3***	***29.2***	***60.8***	***57.4***
Water Supply (MAF)				
Urban	1.5	1.5	8.4	8.0
Agricultural	15.6	15.6	32.8	31.5
Environmental	14.0	10.5	16.3	12.6
Total	***31.1***	***27.6***	***57.5***	***52.1***
Total Shortage (MAF)[4]	**1.8**	**2.2**	**4.9**	**6.1**

Notes:
[1] Water demands, supplies, and shortages are from the 2008 Reclamation Water Supply and Yield Study
[2] Representative dry and average year supplies and demands were based on water use and supply data from the California Water Plan Update 2005 (DWR 2005) adjusted for population growth, increasing urban water use, and reductions in irrigated acreage and environmental flow due to insufficient water supplies.
[3] 2030 Population estimates are from the California Department of Finance (2007)
[4] Total shortages are calculated as the sum of shortages for each category by region (e.g., North Coast, Sacramento River) and, therefore, may not equal the difference between demands and supplies. Shortages were determined on a regional basis, assuming that limitations on conveyance and storage would prevent surpluses from one region or use category from filling shortages in another. Detailed estimates of shortages for each region can be found in the 2008 Reclamation Water Supply and Yield Study in Table A-4 (dry year) and Table A-5 (average year). For categories where supply is greater than demand, the shortage is equal to zero.
Key:
MAF = million acre-feet

Potential Effects of Population Growth on Water Demands A major factor in California's future water picture is population growth. California's population is expected to increase by just over 60 percent above 2005 levels by 2050 (DOF 2007) and could force some of the existing water supplies currently identified for agricultural uses to be redirected to urban uses. A portion of the increased population in the Central Valley would occur on lands currently used for irrigated agriculture. Water that would have been needed for these lands for irrigation would instead be used to serve urban demands. However, since much of the growth would occur on non-irrigated agricultural lands, the required agricultural-to-urban water conversion needed to sustain projected urban water demands would be only partially offset.

The *California Water Plan Update 2013* (DWR 2014) estimates changes in future water demands by 2050, considering three different population growth scenarios as well as climate change. Assuming that recent population growth trends will continue until 2050, Table 1-3 shows the results of this study for an average water year (DWR 2014) for one of three scenarios, the Current Trends scenario.

Table 1-3. Estimated Annual Change in Water Demand in California for 2050

Item	Current Trends
Population (million)	51.0
Irrigated Crop Acreage (million)	8.9
Water Demand Change[1] (MAF)	
Urban	2.9
Agricultural	-3.6
Total	***3.5***

Source: DWR 2014

Note:

[1] Estimated water demand change is the difference between the average demands for 2043—2050 and 1998—2005.

Key:

MAF = million acre-feet

Potential Effects of Climate Change Another potentially significant factor affecting water supply reliability is climate change. Potential effects of climate change are many and complex (DWR 2006), varying through time and geographic location across the State (Reclamation 2011a). Changes in geographic distribution, timing, and intensity of precipitation are projected for the Central Valley (Reclamation 2011a), which could broadly impact rainfall runoff relationships important for flood management as well as water supply. Additionally, there is potential for climate change to increase annual water demand compared to a repeat of historical climate (DWR 2014). Other possible impacts range from potential sea level rise, which could impact coastal areas and water quality, to impacts to overall system storage for water supply.

A reduction in total system storage is widely predicted with climate change. Less water held in snowpack and demand for more flood control space in reservoirs is expected with future climate change. During drought periods, supplies could be further reduced, and expected shortages would be substantially greater.

System Flexibility The CVP and SWP were designed and constructed to accommodate the variability of precipitation in California, seasonally, temporally, and spatially. However, the projects' flexibility has been fully used by population growth and increased environmental and ecosystem commitments and requirements since the projects were constructed (Reclamation 2008b).

Chronic water shortages since the early 1900s have led to groundwater overdraft in many regions across the State. Portions of the CVP and SWP were constructed to reduce groundwater overdraft; however, increasing water supply demands that cannot be met by the CVP or SWP are causing modern-day overdraft conditions.

Increasing CVP and SWP operational constraints have led to growing competition for limited system resources among various users and uses. Urban and required environmental water uses have each increased, resulting in increased competition and conflicting demands for limited water supplies. For example, the CVPIA, implemented in 1993, dedicated project water supplies to environmental purposes. Existing NMFS and USFWS BOs, resulting in increased Delta pumping constraints and other operational restrictions, coupled with drought conditions, have even further decreased CVP deliveries.

Potential Approaches to Address Water Supply Needs As noted by Reclamation's *Water Supply and Yield Study* (Reclamation 2008b), the *California Water Plan Update 2013* (DWR 2014), and the CALFED Programmatic ROD (2000a), an integrated portfolio of solutions, regional and statewide, is needed to meet future water supply needs. The *Water Supply and Yield Study* stated that a "variety of storage and conveyance projects and water management actions have the potential to help fill [the] gap" between water supply and demand in California. The *California Water Plan Update 2013* concluded that to improve public safety, foster environmental stewardship, and support economic stability, California must continue its commitment to integrated water management, promote better alignment of government agency efforts at all levels, and encourage greater investment in innovation and infrastructure, including increased surface storage. Accordingly, California must invest in reliable, high quality, and affordable water conservation; efficient water management; and development of water supplies. Major efforts by multiple agencies are needed to address the complex water resources issues in the State, as demands are expected to continue to exceed supplies in the future.

Ecosystem Resources

The health of the Sacramento River ecosystem, as elsewhere in the Central Valley, has been impacted in the last century by conflicts over the use of limited natural resources, particularly water resources. Many of California's rivers and streams have been harnessed for beneficial uses such as hydropower, flood damage reduction, and water supply, contributing to a decline in habitat and native species populations, and a resulting increase in endangered or threatened species listings under the ESA and CESA.

Constructing Shasta Dam has had both negative and positive effects on environmental resources in the region. While the dam displaced valuable riverine and upland habitat, it also created shoreline and shallow water habitat for aquatic, terrestrial, and avian species in the reservoir area. For example, Shasta Lake is home to a substantial concentration of nesting bald eagles in California.

Shasta Lake Area Various activities have impacted natural resources upstream from Shasta Dam, within the lake, on adjacent lands, and in and near tributary streams. Historical mining, ore processing practices and resulting acid mine drainage, fire suppression, and development in the watershed are among the activities causing the greatest degradation to ecosystem resources in this area. Although most mines in this area are no longer operational and many are currently undergoing remediation, they continue to remain a documented source of metals, acidity, and sediments in the reservoir area.

Aquatic habitats in tributaries to Shasta Lake have been affected by passage barriers and human disturbances that have caused various types of habitat degradation. Fish passage barriers are caused by the presence of road crossings and culverts, grade controls, and adverse water quality conditions, particularly high water temperature or toxic materials. Human disturbances have resulted in downcutting of stream channels, a reduction of shaded riparian habitat, and increased water temperatures. Other types of disturbance (e.g., wildland fire, road construction) have resulted in increased sediment transport into streams and a reduction in spawning habitat due to sedimentation of spawning gravels.

To guide management of the Shasta-Trinity National Forest (STNF), USFS prepared the *Shasta-Trinity National Forest Land and Resource Management Plan* (LRMP) (USFS 1995). Primary goals of the STNF LRMP, which was implemented in 1995, are to integrate a mix of management activities that allows use and protection of forest resources; meets the requirements of guiding legislation; and addresses local, regional, and national issues. The STNF LRMP is intended to guide implementation of the *Aquatic Conservation Strategy of the Northwest Forest Plan* (USFS 1994) for protection and management of riparian and aquatic habitats adjacent to Shasta Lake. However, opportunities exist to further support ongoing USFS programs. These opportunities include improving and restoring environmental conditions by developing self-sustaining natural habitat in the area of Shasta Lake and its tributaries to benefit fish and wildlife resources.

Downstream from Shasta Dam Land and water resources development has caused major resource problems and challenges in the Sacramento River basin, including decreases in anadromous fish and wildlife populations and losses of riparian, wetland, floodplain, and shaded riverine habitat. These decreases and losses have resulted in reduced populations of many plant and animal species.

The quantity, quality, diversity, and connectivity of riparian, wetland, floodplain, and shaded riverine habitat along the Sacramento River have been severely limited through confinement of the river system by levees, reclamation of adjacent lands for farming, bank protection, channel stabilization, and land development. Modification of seasonal flow patterns by dams and water diversions also has inhibited the natural channel-forming processes that drive riparian habitat succession. It is estimated that less than 5 percent of the historical riparian vegetation habitat within the Sacramento River basin remains today (USFWS 2014).

Decreases in quality and quantity of habitat have resulted in reduced populations of various fish and wildlife species. Introduction of nonnative species has also contributed to the decline in native animal and plant species. In addition, the lack of linear continuity of riparian habitat has impacted the movement of wildlife species among habitat areas, adversely affecting dispersal, migration, emigration, and immigration. For many species, these conditions have resulted in reduced wildlife numbers and population viability.

Ecosystem restoration along the Sacramento River has been the focus of several ongoing programs, including the Senate Bill 1086 Program, CVPIA, CALFED, and Central Valley Habitat Joint Venture. Despite these efforts, a significant need remains to conserve and restore ecosystem resources along the Sacramento River.

Endangered and threatened fish and wildlife populations, critical habitat, and sensitive Delta ecosystems are also declining. The decline is especially pronounced in the case of pelagic fish species in the Delta, including delta smelt, striped bass, threadfin shad, and longfin smelt. Monitoring results indicate that the threatened delta smelt population continues to remain at or near all-time lows. In 2006, the USFWS was petitioned to upgrade the status of delta smelt to endangered (The Center for Biological Diversity et al. 2006). In 2010, the USFWS conducted a 5-year review and found delta smelt warranted the upgrade in status; however, the listing was precluded by other higher priority listing actions (Volume 75, Federal Register (FR), page 17667 (75 FR 17667 (April 7, 2010)). Longfin smelt were petitioned for listing as endangered in 2007 (The Center for Biological Diversity et al. 2007). The USFWS found that the Bay-Delta DPS does warrant listing; however, as with the delta smelt, the listing is precluded by other higher priority actions. Therefore, longfin smelt have been added to the candidate list (77 FR 19756 (April 2, 2012)). Current planning efforts, such as the Bay Delta Conservation Plan (BDCP)/Delta Habitat Conservation and Conveyance Program are focused on developing ecological solutions to protect Delta fisheries while providing a sustainable and reliable water conveyance system for the CVP and SWP.

Flood Management

Large and small communities and agricultural lands in the Central Valley are subject to flooding along the Sacramento River. The comprehensive flood control system in the Sacramento River basin includes river, canal, and stream channels; levees; flood relief bypasses; weirs; flood relief structures; a natural overflow area; outfall gates; and drainage pumping plants.

Flooding poses risks to human life, health, safety, and property. Physical impacts from flooding include damage to buildings, contents, automobiles, agricultural crops, equipment, etc. Threats from flooding are caused by many factors, including overtopping or sudden failures of levees, which can cause deep and rapid flooding with little warning, threatening lives and public safety. In addition, urban development in flood-prone areas has exposed the public to the risk of flooding.

Hydropower

While California is the second largest consumer of electricity in the nation, it is also the most energy efficient. Although California has 12 percent of the nation's population, it uses only 7 percent of the nation's electricity (DOE 2014). Even so, demands for electricity are growing at a rapid pace. California's peak demand for electricity is expected to increase at a rate of approximately 1.5 percent per year through 2022, from about 60,000 megawatts (MW) in 2011 to about 70,000 MW by 2022 (California Energy Commission 2012). There are, and will continue to be, increasing demands for new electrical energy supplies, including clean energy sources, such as hydropower. Executive Orders S-14-08 and S-21-09, issued in 2008 and 2009, respectively, established a goal of using renewable energy sources, including hydropower, for 33 percent of the State's energy consumption by 2020 (California Public Utilities Commission 2011). To meet renewable energy goals, significant increases in non-dispatchable intermittent renewable resources, such as wind and solar generation, will need to be added to California's power system. This means that other significant flexible generation resources will be needed to support and integrate renewable generation. Adding to the need for additional energy sources, existing nuclear power plants are nearing the end of their design lives and some may be offline within the next 10 to 20 years. For example, the San Onofre Nuclear Generating Station in San Diego County is in the process of decommissioning.

Recreation

As the population of the State continues to grow, demands will increase substantially for water-oriented recreation at and near the lakes, reservoirs, streams, and rivers of the Central Valley. According to the *California Water Plan Update 2013* (DWR 2014), the Central Valley is experiencing dramatic population growth, but currently has insufficient access to recreation opportunities. Further increases in demand, accompanied by relatively static recreation resources, will cause additional issues at existing recreation areas. These challenges will be especially pronounced at Shasta Lake, which is one of the most visited recreation destinations in the State and in the region. Even under current levels of demand, USFS, which manages recreation at Shasta Lake, has expressed concern about seasonal access and capacity problems at existing marinas and USFS facilities. A substantial and increasing need exists to improve recreation-related facilities and conditions at Shasta Lake.

Water Quality

The Sacramento River and the Delta support fish and wildlife while providing water supplies for urban, agricultural, and environmental uses across the State. Saltwater intrusion, municipal discharges, agricultural drainage, and water project flows and diversions have led to water quality issues within the Delta, particularly related to salinity, that have resulted in significant declines in pelagic populations (Regional Water Boards, State Water Board, and CalEPA 2006). Urban and agricultural runoff, and runoff and seepage from abandoned mining operations, have resulted in elevated levels of pesticides, phosphorous, mercury, and other metals in the Sacramento River.

Planning efforts, such as the BDCP, are intended to allow implementation of projects that restore and protect water supply and reliability, water quality, and ecosystem health in the Delta to proceed within a stable regulatory framework. Additional operational flexibility could provide further opportunities to improve Sacramento River and Delta water quality conditions.

1.3 Setting and Location

Shasta Dam and Shasta Lake are located on the upper Sacramento River in northern California, approximately 9 miles northwest of Redding in Shasta County. The SLWRI includes both a primary and extended study area because of the potential influence of the proposed modification of Shasta Dam and subsequent system operations and water deliveries on resources over a large geographic area. The primary study area includes the following:

- Shasta Dam and Shasta Lake
- Lower reaches of three primary tributaries flowing into Shasta Lake (Sacramento, McCloud, and Pit rivers) and all smaller tributaries flowing into the lake
- Sacramento River between Shasta Dam and RBPP, including tributaries at their confluence
- Trinity and Lewiston reservoirs

The extended study area includes the following:

- Sacramento River downstream from RBPP, including portions of major tributaries, namely the American and Feather river basins downstream from CVP and SWP facilities
- Delta
- San Joaquin River basin at and downstream from CVP facilities (Friant and New Melones reservoirs)
- CVP and SWP facilities and water service areas

The SLWRI study area includes other parts of California with resource programs or projects that could potentially be directly or indirectly influenced by modifying Shasta Dam and Reservoir. As discussed above, the study area includes the Sacramento and San Joaquin rivers and the Delta system, plus the CVP and SWP facilities and water service areas. For analyses of each resource that may be directly or indirectly affected by the project, the study area is subdivided into specific geographic areas, as described in the following sections.

1.3.1 Primary Study Area

The primary study area includes Shasta Dam and Shasta Lake, the lower portions of all contributing major and minor tributaries that would be affected by increasing storage in the reservoir, and the Sacramento River upstream from RBPP to Shasta Dam. Figure 1-3 shows the portion of the primary study area downstream from Shasta Dam.

Shasta Dam

Shasta Dam is a curved gravity concrete dam on the Sacramento River north of Redding, California. The dam is 602 feet high and 3,460 feet long, with a base width or thickness of 543 feet. Upon construction, Shasta Dam was the second tallest and second largest concrete dam in the world, exceeded only by Hoover Dam (located in Clark County, Nevada) in height and by Grand Coulee Dam (located in Grant County, Washington) in volume and surface area (Reclamation 2004).

Shasta Lake and Vicinity

Created by Shasta Dam, Shasta Lake is the largest reservoir in California, with a surface area of approximately 29,500 acres, a volume of 4.55 MAF, and approximately 400 miles of shoreline. The reservoir's watershed receives a substantial amount of precipitation relative to the rest of California; only a limited region in the State's far northwest corner receives more. The three major tributaries to Shasta Lake are the Sacramento, McCloud, and Pit rivers. Many smaller tributary creeks and streams (both seasonal and perennial) flow into these major tributaries and the reservoir itself. The major tributaries are described in more detail below.

Sacramento River The Sacramento River drains an area of approximately 430 square miles. Its headwaters include portions of Mount Shasta and the Trinity and Klamath mountains. The Sacramento River flows south from its headwaters for about 40 miles before entering Shasta Lake.

McCloud River The McCloud River drains an area of approximately 600 square miles. Its headwaters are at Colby Meadows near Bartle, California. The McCloud River flows southwesterly from its headwaters for about 50 miles to its terminus at Shasta Lake. As part of the McCloud-Pit Hydroelectric Project, the majority of the McCloud River flows are diverted to the Pit River at the McCloud Dam, through the McCloud-Iron Canyon Diversion Tunnel and Iron Canyon Reservoir.

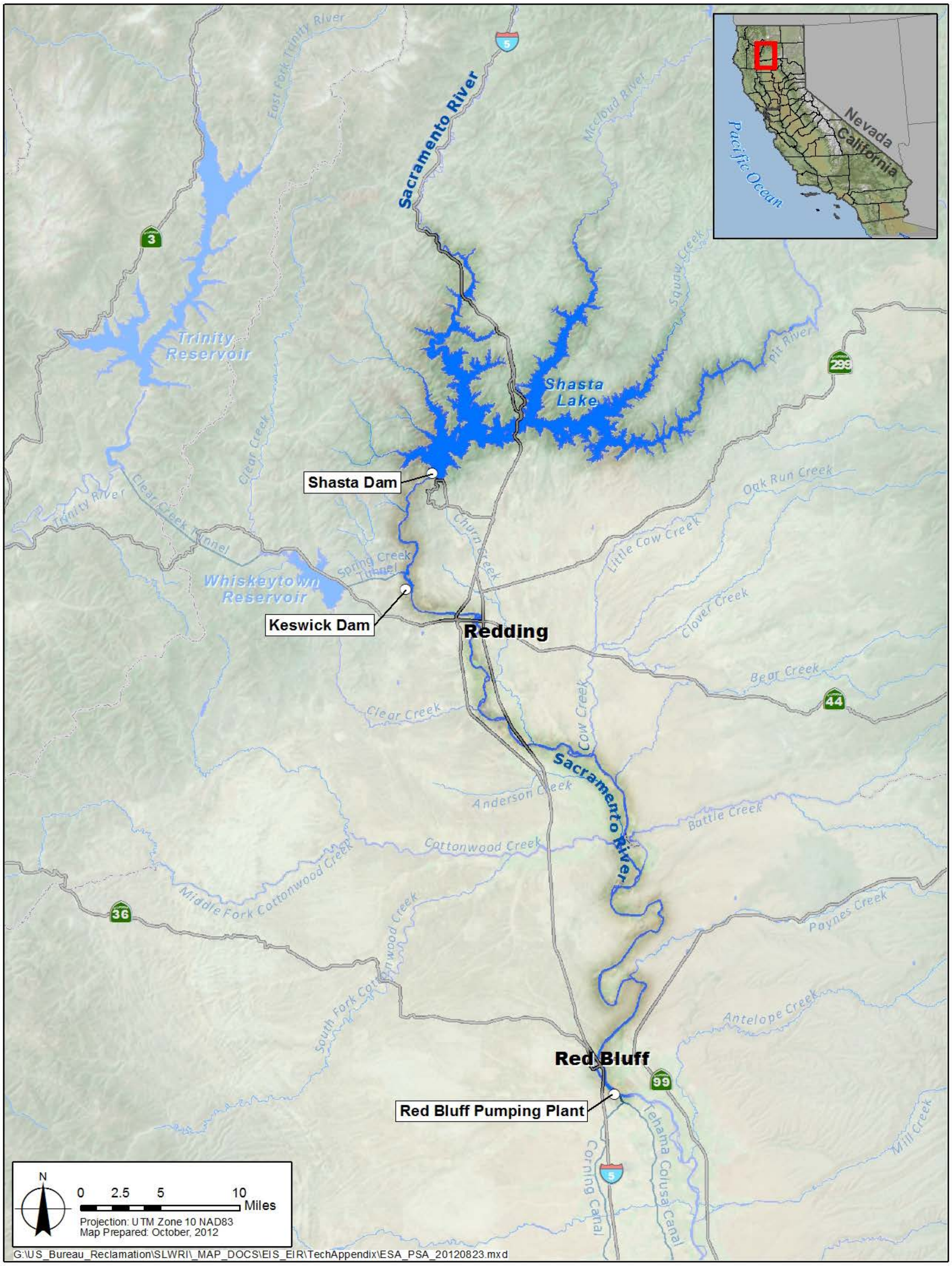


Figure 1-3. Primary Study Area—Shasta Lake Area and Sacramento River from Shasta Dam to Red Bluff Pumping Plant

Pit River The Pit River watershed is located in northeastern California and southeastern Oregon. The north and south forks of the Pit River drain the northern portion of the watershed. The North Fork Pit River originates at the outlet of Goose Lake, and the South Fork originates in the south Warner Mountains at Moon Lake in Lassen County. The Pit River is joined by the Fall River in Shasta County and has 21 named tributaries, totaling approximately 1,050 miles of perennial streams and encompassing approximately 4,700 square miles.

Upper Sacramento River — Shasta Dam to Red Bluff Pumping Plant

This portion of the primary study area includes an approximately 65-mile-long stretch of the Sacramento River corridor from Shasta Dam to RBPP, including tributaries at their confluence. The Sacramento River corridor within this reach also includes proposed sites for riparian, floodplain, and side channel habitat restoration and areas proposed for gravel augmentation. Communities located along this stretch of the river are Redding, Anderson, and Red Bluff. The northern portion of this reach is located in Shasta County and the southern portion is in Tehama County.

Shasta Dam, Keswick Dam, Anderson-Cottonwood Irrigation District Dam, and Red Bluff Diversion Dam are located on the Sacramento River in this area. The RBPP is directly adjacent to the Red Bluff Diversion Dam, which is currently operated year round with all of the gates permanently raised. Urban, residential, industrial, and agricultural land uses predominate along the upper Sacramento River between Shasta Dam and RBPP.

The location of the RBPP was chosen as the downstream boundary of the primary study area because cold water released from Shasta Dam significantly influences water temperature conditions in the Sacramento River between Keswick Dam and the RBPP (NMFS 1993). After the RBPP, the river landscape changes to a broader alluvial stream system. The broader, slower nature of an alluvial stream system allows ambient air temperature to have a greater effect on the temperature of the Sacramento River.

Trinity and Lewiston Reservoirs Trinity and Lewiston reservoirs impound the upper Trinity River approximately 60 and 67 miles, respectively, southwest of the headwaters near Mount Eddy (USFS 2005). Trinity Reservoir has a watershed of approximately 165 square miles and a usable storage capacity of approximately 2,438,000 acre-feet. Flow into Lewiston Reservoir, with a capacity of approximately 14,700 acre-feet, is completely regulated by releases from Trinity Dam (USFS 2005). At Lewiston Dam, a portion of Trinity River flows are diverted to the Sacramento River basin through Clear Creek Tunnel and Whiskeytown Lake (See Figure 1-4).

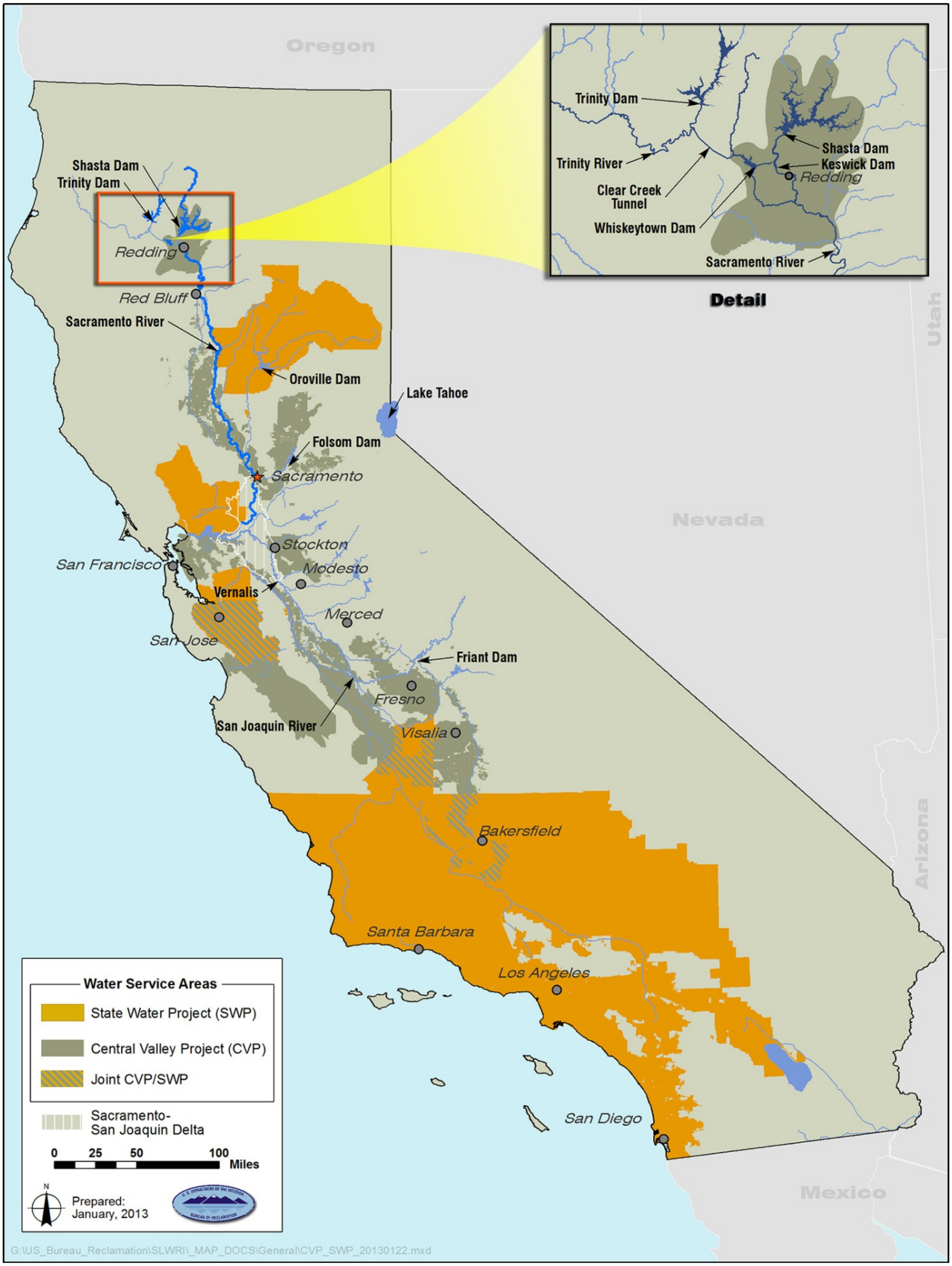


Figure 1-4. Central Valley Project and State Water Project Facilities and Water Service Areas

1.3.2 Extended Study Area

The extended study area includes the Sacramento River downstream from RBPP south (along the Sacramento River) to the Delta. It also includes the San Francisco Bay/Sacramento-San Joaquin Delta (Bay-Delta) area and portions of the American and Feather river basins, the San Joaquin River basin, and the CVP and SWP facilities and water service areas (Figure 1-4).

Sacramento River from Red Bluff Pumping Plant to the Delta

The segment of the extended study area between RBPP and the Delta includes the Sacramento River, tributaries at their confluence, and portions of major tributaries that may be affected by the project, namely, the Feather and American rivers. The Yuba River is a major tributary to the Feather River, but the Yuba River is not considered part of this segment of the extended study area for two reasons: it is geographically separated from the Sacramento River, and its watershed has no CVP or SWP facilities that could be indirectly affected by increased storage at Shasta Lake. Lake Oroville is a major SWP facility on the Feather River, and Folsom Lake is a major CVP facility on the American River.

The middle reach of the Sacramento River between Red Bluff and Colusa is approximately 100 miles long. The lower reach of the Sacramento River between Colusa and the Delta is approximately 84 miles long.

The Sacramento River Hydrologic Region, as defined by DWR, is the main water supply for much of California's urban and agricultural areas. Annual runoff averages about 22.4 MAF, which is nearly one-third of California's total runoff. M&I and agricultural supplies to the Sacramento Valley region are about 8 MAF, with groundwater providing approximately 2.5 MAF of that total. Much of the remainder of the runoff in the Sacramento River watershed goes to dedicated in-channel flows that support various environmental requirements, including instream flow and Delta salinity requirements (DWR 2003).

Sacramento-San Joaquin Delta

Surface water resources in the Delta are influenced by the interaction of tributary inflows, tides, Delta hydrodynamics, local Delta diversions and exports, and water transfers. The Delta receives runoff from a watershed that includes more than 40 percent of California's land area and covers approximately 750,000 acres. Tributaries that discharge directly into the Delta include the Sacramento, San Joaquin, Mokelumne, Cosumnes, and Calaveras rivers. Existing surface water conditions in the Delta are the result of the many changes that have occurred as the Delta and its watershed have been developed over the past 150 years.

Tides move water twice daily from San Francisco Bay into the Delta. The location of the mixing zone between freshwater from the Delta and saline water from the San Francisco Bay varies with the amount of Delta outflow and tides. Saltwater intrusion into the Delta during summer is controlled by tides, freshwater inflows from reservoir releases, and Delta pumping. Average incoming and outgoing Delta tidal flow is approximately 170,000 cubic feet per second, and average net Delta outflow is about 30,000 cubic feet per second, or about 21 MAF per year, measured at Chipps Island.

San Joaquin River Basin to Delta

The San Joaquin River basin includes the Central Valley south of the Delta. This area is drier than the Sacramento Valley, and flows into the Delta from the San Joaquin River are considerably smaller than those from the Sacramento River. The river also is subject to extreme variations in flow and water quality.

The San Joaquin River watershed above Vernalis (the point at which the river enters the Delta) is 13,356 square miles. Inflows from the Merced (farthest upstream), Tuolumne, and Stanislaus rivers contribute more than 60 percent of the flows in the San Joaquin River, as measured at Vernalis. Upstream from the Merced River, nonflood flows in the San Joaquin River consist primarily of Restoration Flows released under the San Joaquin River Restoration Program (SJRRP). Restoration Flows are currently recaptured from the river at Mendota Pool (approximately 87 miles upstream from the Merced River confluence). As the capacity of the San Joaquin River downstream from Mendota Pool is gradually increased as part of the SJRRP, Restoration Flows will increase downstream from Mendota Pool, and will ultimately reach the Delta.

The major rivers of the San Joaquin system have contributed an average of about 5.5 MAF to Delta inflow, with an annual range of 1.1 to 15 MAF. Historical unimpaired flows on the Stanislaus, Tuolumne, Merced, and San Joaquin rivers averaged a total of 5.6 MAF. Numerous dams, reservoirs, and diversions are located on these rivers and others in the San Joaquin system. New Melones Reservoir on the Stanislaus River and Friant Dam on the San Joaquin River are part of Reclamation's CVP system.

Central Valley Project Facilities and Water Service Areas

The CVP supplies irrigation water to the Sacramento and San Joaquin valleys; domestic water to cities and industries in Sacramento County and the east and South San Francisco Bay area; and water to fish hatcheries and wildlife refuges throughout the Central Valley. The CVP delivers approximately 7 MAF of water per year. CVP facilities include 20 dams and reservoirs with a combined storage capacity of more than 11 MAF, 39 pumping plants, 2 pumping-generating plants, 11 power plants, and more than 500 miles of major canals and aqueducts. CVP divisions include Trinity River, Shasta Lake, Sacramento River, American River, Delta, West San Joaquin, San Felipe, East Side, and Friant.

The CVP has three primary storage facilities in northern California: Shasta Dam and Shasta Lake, Trinity Dam and Clair Engle Lake, and Folsom Dam and Folsom Lake. Major CVP storage facilities south of the Delta are New Melones Reservoir on the Stanislaus River, Millerton Lake on the San Joaquin River, and

San Luis Reservoir, which is a pumped-storage reservoir on the west side of the San Joaquin Valley and is shared with the SWP.

The Delta-Mendota Canal is the main conveyance facility of the CVP. This canal conveys water from the C.W. “Bill” Jones Pumping Plant (formerly known as the Tracy Pumping Plant) in the south Delta near Byron to agricultural lands in the San Joaquin Valley. Water not delivered directly is diverted from the Delta-Mendota Canal at the O’Neill Pumping Plant into O’Neill Forebay. The water then flows along the San Luis Canal to CVP contractors in the San Joaquin Valley or is lifted into San Luis Reservoir through the Gianelli Pumping/Generating Plant for later use. The majority of the remaining water continues to the southern Central Valley, with some water being diverted to Santa Clara County.

State Water Project Facilities and Water Service Areas

The SWP is the largest state-built, multipurpose water project in the country. DWR operates and maintains the SWP, which conveys an annual average of 2.5 MAF of water through 20 pumping plants, 4 pumping-generating plants, 5 hydroelectric powerhouses, 34 storage facilities, and about 700 miles of open canals and pipelines. The SWP is operated in conjunction with the CVP according to the 1986 *Agreement Between the United States and the State of California for the Coordinated Operation of the Central Valley Project and the State Water Project*, commonly known as the “Coordinated Operations Agreement.” This agreement defines how Reclamation and DWR share their joint responsibility to meet Delta water quality standards and the water demands of senior water right holders, and how the two agencies share surplus flows.

DWR operates the SWP to export Delta flows and store and transfer water from the Feather River basin to the San Joaquin Valley, South San Francisco Bay, areas north of Suisun Bay, coastal counties, and ultimately to southern California. In 1951, the State Legislature authorized the SWP for water supply, flood control, hydropower generation, recreation, and fish and wildlife purposes. Approximately 25 million of California’s estimated 37 million residents benefit from SWP water, which also irrigates about 750,000 acres of farmland, mainly in the southern San Joaquin Valley. Of the contracted water supply, M&I users have received about half of the total water delivered over the last 20 years; the remainder is supplied for agricultural use. A total of 29 contracting agencies receive water from the SWP.

In the southern Delta, the SWP diverts water from Clifton Court Forebay for delivery south of the Delta. Harvey O. Banks Pumping Plant lifts water from Clifton Court Forebay into Bethany Reservoir. Some of the water delivered to Bethany Reservoir is pumped at South Bay Pumping Plant for delivery through the South Bay Aqueduct to SWP contracting agencies in the San Francisco Bay Area. Most of the water delivered to Bethany Reservoir flows into the California Aqueduct, the main conveyance facility of the SWP. Along the western San Joaquin Valley, the California Aqueduct transports water through

Gianelli Pumping/Generating Plant for storage in San Luis Reservoir until it is needed for later use. The 444-mile-long California Aqueduct conveys water to the agricultural lands of the San Joaquin Valley and the urban regions of southern California. The west branch of the aqueduct ends in Castaic Lake, and the east branch terminates at Lake Perris in southern California.

1.4 NEPA Compliance

NEPA requires a planning process to inform stakeholders, public agencies, and decision makers of the significance of potential environmental effects that may result from taking an action or implementing a Federal action. These processes disclose the significance of the impacts of a proposed action on the human environment, including the natural and physical environment and the relationship of people with that environment. The environmental impacts of a range of reasonable alternatives, including a no-action alternative, are analyzed in this EIS as required under NEPA.

1.4.1 NEPA Process

Reclamation is the Federal lead agency for NEPA compliance (42 U.S. Code 4321 et seq.). Based on a review of technical data and the scope of the SLWRI, Reclamation determined that the proposed action would result in significant impacts and that an EIS was the appropriate NEPA document to be prepared. Consequently, the DEIS was made available for public review and comment in June 2013, followed by the release of this Final EIS.

The EIS satisfies NEPA requirements for formulating and evaluating alternative actions, disclosing environmental impacts, and identifying potential mitigation measures. Section 1.5, "Intended Use of EIS," describes the roles and responsibilities of Federal, State, and local agencies, and includes a list of agencies that may use the EIS for NEPA compliance or to inform decisions regarding resources within their jurisdictions. Chapter 32, "Final EIS," provides an overview of the Final EIS, including public involvement, consultation, and coordination efforts for the EIS; a description of the preferred alternative; document availability and distribution; and next steps.

1.5 Intended Use of EIS

The purpose of an EIS is not to recommend approval or rejection of a project, but to provide information to aid the public and decision makers/permitting agencies in the decision-making process. An EIS identifies and evaluates alternatives that meet the project objectives, analyzes the potential environmental effects, and identifies measures to reduce or avoid potential environmental effects resulting from the action alternatives (i.e., mitigation measures). An EIS also must disclose adverse environmental impacts that cannot be avoided, cumulative impacts, the relationship of short-term uses and long-term productivity, and irreversible and irretrievable commitments of resources. In addition, NEPA requires that an EIS consider indirect effects of a project, which are often the result of growth inducement.

The DEIS was released to the public in June 2013 and was circulated for review and comment by agencies, stakeholders, and the public to inform and engage interested persons in the planning and NEPA processes. Public outreach, including public workshops and hearings, was conducted during the 90-day public review period for the DEIS. Comments received during the public review period were considered and addressed and all comments and responses to comments are included in this Final EIS in Chapter 33, “Public Comments and Responses.”

1.5.1 CALFED Tiering

The 2000 CALFED PEIS/R Preferred Program Alternative and associated CALFED Programmatic ROD recommended five surface water storage projects to be pursued with project specific studies. These studies included Shasta Lake Enlargement, Los Vaqueros Reservoir Enlargement, Sites Reservoir, In-Delta Storage, and development of storage in the upper San Joaquin River Basin. As described in the CALFED Programmatic ROD:

> *For actions contained within the Preferred Program Alternative that are undertaken by a CALFED Agency or funded with money designated for meeting CALFED purposes, environmental review will tier from the [CALFED] Final Programmatic EIS/R.*

Accordingly, since the SLWRI is an action contained within the CALFED Preferred Program Alternative, this EIS tiers to the CALFED PEIS/R. The CALFED Programmatic ROD describes tiering as follows:

> *Whenever a broad environmental impact analysis has been prepared and a subsequent narrower analysis is then prepared on an action included within the entire program or policy, the subsequent analysis need only summarize the issues discussed in the broader analysis and incorporate discussions from the broader analysis by reference. This is known as tiering. Tiered documents focus on issues specific to the subsequent action and rely on the analysis of issues already decided in the broader programmatic review. Absent new information or substantially changed circumstances, documents tiering from the CALFED Final Programmatic EIS/R will not revisit the alternatives that were considered alongside CALFED’s Preferred Program Alternative nor will they revisit alternatives that were rejected during CALFED’s alternative development process.*

As discussed in more detail in Chapter 2, Section 2.1.3, "Planning Constraints and Other Considerations," preliminary studies in support of the CALFED PEIS/R considered more than 50 surface water storage sites throughout California and recommended more detailed study of the five sites identified in the CALFED Programmatic ROD (CALFED 2000a, 2000b, 2000c). Consistent with the above guidance in the CALFED Programmatic ROD, this EIS relies on evaluations and alternatives development and screening included in the CALFED PEIS/R, and focuses on the subsequent action of evaluating the enlargement of Shasta Lake.

Although conditions have changed since the CALFED Programmatic ROD was issued in July 2000, the Bay-Delta problems for which the alternatives were formulated persist today. The purpose of CALFED was to develop and implement a long-term comprehensive plan that would restore ecological health and improve water management for beneficial uses of the Bay-Delta system. The goal of CALFED was to concurrently and comprehensively address problems of the Bay-Delta system within four critical resource categories: ecosystem quality, water quality, water supply reliability, and levee system integrity. Although conditions have changed in the system since 2000 and progress has been made towards the CALFED goals, the fundamental needs for which the CALFED alternatives were formulated to address are still relevant today. For example, unreliable water supply, declining fish and wildlife habitat, continuing water quality issues, and the levee system are still key concerns for the Bay-Delta system. Accordingly, there is no new information or substantially changed circumstances that require Reclamation to revisit the CALFED alternatives as the alternatives, analyses, and recommended actions remain relevant today.

The CALFED PEIS/R was a programmatic-level document to select a long-term plan – Preferred Program Alternative – for implementation over a 30-year time frame. As described in the CALFED Programmatic ROD:

> *The Preferred Program Alternative is a set of programmatic actions, studies, and conditional decisions. It includes the broadly described actions that set the long-term overall direction of the Program. The description of the alternative is programmatic in nature, intended to help agencies and the public make decisions on the broad methods to meet program purposes. The Preferred Program Alternative description is an important legal element of compliance with CEQA and NEPA. The Preferred Program Alternative is not intended to define the site specific actions that will ultimately be implemented.*

This EIS builds on the CALFED PEIS/R analysis to account for updates to hydrology, demands, facilities, and CVP and SWP water operations; recent and relevant BOs; and reasonably foreseeable actions expected to occur in the study area to provide more specific information about the potential for the action alternatives to cause wide-ranging effects.

1.5.2 Intended Use of Final EIS

Reclamation posted the Final EIS at http://www.usbr.gov/mp/slwri for public review and issued a notice in the Federal Register and press release describing the public release of the Final EIS. It will be used by the Federal lead agency when considering approval of the proposed action or an alternative to the proposed action. All cooperating agencies and other Federal, State, and local agencies with permitting or approval authority over any aspect of the proposed action are expected to use the information contained in this Final EIS to meet most, if not all, of their information needs, to make decisions and/or issue permits with respect to the proposed action. Table 1-4 presents the roles and responsibilities of Federal, State, and local agencies that may use the Final EIS to support their decision-making needs.

This Final EIS is being published along with the Final Feasibility Report. The Final Feasibility Report incorporates information contained in this Final EIS by reference, and will be used to determine the type and extent of Federal interest in enlarging Shasta Dam and Reservoir. This Final EIS and the Final Feasibility Report will be used together to support the Federal decision. Typically, a ROD is the final step in the NEPA process and would document any decision on which actions, if any, to take to address the primary objectives.

Table 1-4. Agency Roles and Responsibilities

Agency	Role/Responsibility
Federal	
U.S. Department of the Interior Secretary	Ultimate responsibility for recommending actions to Congress. Also responsible for ROD.
U.S. Army Corps of Engineers (cooperating agency)	Permitting under Section 404 of the Clean Water Act; permitting under Sections 9, 10, and 13 of the Rivers and Harbors Act
U.S. Department of the Interior, Bureau of Indian Affairs (cooperating agency)	Participating in the SLWRI feasibility study
U.S. Department of the Interior, Bureau of Land Management	Reviewing SLWRI studies for consistency of project facilities with management of the Sacramento River Bend Management Area
U.S. Department of the Interior, Bureau of Reclamation	Serving as NEPA lead agency
U.S. Fish and Wildlife Service	Completing Federal Endangered Species Act consultation and incidental take authorization; verifying compliance with the Fish and Wildlife Coordination Act
National Marine Fisheries Service	Completing Federal Endangered Species Act consultation and incidental take authorization; verifying compliance with the Magnuson-Stevens Act

Table 1-4. Agency Roles and Responsibilities (contd.)

Agency	Role/Responsibility
Federal (contd.)	
U.S. Department of Agriculture, Forest Service (cooperating agency)	Verifying consistency of project facilities with management of the Shasta-Trinity National Forest and Whiskeytown-Shasta-Trinity National Recreation Area; regulating occupancy and use of National Forest System (NFS) lands under the Federal Land Policy Management Act and other authorities as appropriate
U.S. Environmental Protection Agency	Reviewing impacts on air quality for compliance with the Clean Air Act and State Implementation Plan; verifying compliance with the Safe Drinking Water Act; reviewing and filing the EIS
State	
California Air Resources Board	Verifying compliance with criteria pollutant standards
California Department of Boating and Waterways	Verifying compliance with the California Harbors and Navigation Code
California Department of Conservation	Designating Important Farmland for the State
California Department of Fish and Wildlife (trustee agency)	Completing California Endangered Species Act consultation and incidental take authorization; permitting under Section 1602 of the Fish and Game Code (streambed alteration agreement); completing consultation as a trustee agency
California Department of Forestry and Fire Protection	Providing fire protection services to unincorporated areas
California Department of Parks and Recreation	Verifying consistency with management of State Park lands
California Department of Transportation	Issuing an encroachment permit and/or approving a transportation management plan
California Department of Water Resources	Operating the SWP; participating in the SLWRI feasibility study
California Department of Toxic Substances Control	Verifying compliance with regulations for generation, transportation, treatment, storage, and disposal of hazardous waste
California Energy Commission	Verifying compliance with State energy policies
California Highway Patrol	Verifying that the project would not interfere with any emergency response plan or emergency response times
California Natural Resources Agency	Verifying that California's natural and cultural resources are protected, and complying with the California Wild and Scenic River Act
Central Valley Flood Protection Board (formerly The Reclamation Board)	Issuing levee and floodway encroachment permits
California Office of Historic Preservation	Conducting consultation pursuant to Section 106 of the National Historic Preservation Act
State Lands Commission	Verifying consistency with the management of lands managed by the commission; possibly issuing a State Lands lease

Table 1-4. Agency Roles and Responsibilities (contd.)

Agency	Role/Responsibility
State (contd.)	
Native American Heritage Commission	Identifying sacred sites and Most Likely Descendants for Native American burials; providing Native American contact information
State Water Resources Control Board, Regional Water Quality Control Boards	Issuing National Pollutant Discharge Elimination System permitting under Section 402 of the Clean Water Act; issuing certification under Section 401 of the Clean Water Act; issuing water right permits
Delta Stewardship Council	Consistency with the Delta Plan
California Water Commission	Quantification of public benefits of water storage projects
Local	
Shasta County Air Quality Management District	Reviewing impacts on air quality and granting authority to construct/permit to operate
Shasta County	Verifying compliance with the State's Surface Mining and Reclamation Act; issuing other possible construction authorizations/ encroachment permits
Tehama County	Verifying compliance with the State's Surface Mining and Reclamation Act; issuing other possible construction authorizations/ encroachment permits
Resource Conservation Districts	Verifying consistency with protected agricultural lands in the project's primary and extended study areas

Key:
EIS = environmental impact statement
NEPA = National Environmental Policy Act
NFS = National Forest System
SLWRI = Shasta Lake Water Resources Investigation
SWP = State Water Project
ROD = Record of Decision
State = State of California

1.5.3 USFS Use of EIS

The following sections describe the USFS purpose and need, proposed USFS permitting actions, and related actions that may be required if a project is authorized for construction.

Background

Reclamation is evaluating the feasibility of raising Shasta Dam to increase water storage capacity in Shasta Lake. The increased reservoir would expand the inundation area onto National Forest System (NFS) lands within the NRA. The USFS has jurisdiction over the NFS lands within the NRA. Expansion of the reservoir would require modifications or relocations of USFS facilities, revisions to special use permits, and amendments to the STNF LRMP that would be affected by the expansion of the reservoir. Reclamation and the USFS would work cooperatively to implement the decisions identified below.

Purpose and Need for USFS Permitting Actions

The purpose of the proposed action is to respond to a proposal from Reclamation to modify Shasta Dam and expand Shasta Lake. The USFS action is needed because much of the increased reservoir inundation and connected actions would occur on NFS lands which are under USFS jurisdiction. The USFS manages the NRA to provide, in a manner coordinated with the other purposes of the CVP, for public outdoor recreation use and enjoyment of NRA lands, and conservation of scenic, scientific, historic, and other values contributing to public enjoyment of such lands and waters.

USFS Decision Framework

Subject to Congressional authorization of a project, the USFS decision would:

- Determine how to remove merchantable timber or other vegetation that would be cleared as part of this project Identify the specific modifications or relocations of USFS facilities

- Identify the specific permits authorizing improvements on NFS lands that are affected by the project and that will require new authorization or permit amendment

- Amend the STNF LRMP standards and guidelines as necessary

Reclamation and the USFS entered into a Memorandum of Agreement (MOA) in 1986 for the coordinated administration of the Shasta and Trinity Units of the NRA with the CVP. Reclamation and the USFS will develop a supplemental agreement that will address agency specific responsibilities for management of resources affected by project implementation.

Proposed USFS Actions

If Congress authorizes a project involving modifications of Shasta Dam and Reservoir, the following actions would be subject to USFS jurisdiction if they are located on NFS land.

Vegetation Clearing in the Inundation Zone Vegetation would be managed within the inundation zone, consistent with the treatments proposed for vegetation management areas described in Chapter 2 of this EIS. Treatments would range from no treatment to full removal. The merchantable timber may be cut and sold without advertisement, as provided by 36 CFR Section 223.12.

Constructing Dikes on NFS lands to Protect Local Infrastructure Dikes would be constructed by Reclamation in select areas to protect local infrastructure from inundation. Reclamation would also develop local sources for fill material. Both dikes and associated borrow sites are proposed on NFS lands in the following areas: dikes in the vicinity of Lakeshore and Bridge Bay, and various locations for the borrow areas.

Relocation or Replacement of Recreation Facilities Recreation facilities impacted by increased inundation would be relocated or replaced by Reclamation. This includes facilities operated under permit such as resorts and marinas, and USFS-operated facilities such as campgrounds and boat ramps. The USFS would have a connected action to amend the affected permits or issue new permits for privately operated recreation facilities. Facilities impacted include USFS administrative facilities including Turntable Bay and Lakeshore Fire Station; USFS recreation facilities; and permitted recreation facilities.

Relocation, Modification, or Protection of Infrastructure Reclamation would relocate or modify infrastructure such as roads, trails, water systems, and sewer systems impacted by the inundation zone. This includes facilities operated under permit such as power lines and local roads, and USFS infrastructure such as roads and trails. For these facilities, the USFS action would include amending the affected permits for the infrastructure relocated or modified as part of the project. Potential modified or relocated infrastructure may include the following or similar: USFS roads, USFS trails, other permitted roads (e.g., Shasta County, private property access roads, utility access road, railroad access roads), power line permits, water systems (e.g., Lakeshore Heights water storage, Shasta County Service Areas 2 and 6), and telecommunications. For some facilities, dikes would be constructed by Reclamation to protect local infrastructure from inundation. Reclamation would also develop local sources for fill material. Both dikes and associated borrow sites are proposed on NFS lands in the following areas: dikes in the vicinity of Lakeshore and Bridge Bay, and various locations for the borrow areas.

Shasta-Trinity National Forest Land and Resource Management Plan The overall project actions, as authorized by Congress, may not be consistent with the STNF LRMP (USFS 1995) standards and guidelines. A project-specific STNF LRMP amendment may be required to resolve conflicts with USFS actions described above and the LRMP standards associated with caves, visual quality, late successional reserves, riparian reserves, survey and manage species, and Shasta snow-wreath. The USFS decision would include a project-specific exception to these standards if a conflict exists.

Caves The STNF LRMP adopted a standard for cave management that states:

> *Manage these unique habitats on a site-by-site basis to protect their existing micro environments and the viability of dependent animal and plant species. Manage nearby water sources to perpetuate natural cave processes.*

Visual Quality The STNF LRMP adopted Visual Quality Objectives (VQO) for the planning area. VQOs that may be affected by action alternatives include retention, partial retention, and modification.

Late-Successional Reserves The STNF LRMP adopted standards for the development of new facilities that may adversely affect Late-Successional Reserves. The STNF LRMP specifies:

> *New development proposals that address public needs or provide significant public benefits, such as powerlines, pipelines, reservoirs, recreation sites, or other public works projects will be reviewed on a case-by-case basis and may be approved when adverse effects can be minimized and mitigated. These will be planned to have the least possible adverse impacts on Late-Successional Reserves. Developments will be located to avoid degradation of habitat and adverse effects on identified late-successional species.*

Riparian Reserves The STNF LRMP direction for surface water developments in Riparian Reserves states:

> *For hydroelectric and other surface water development proposals, give priority emphasis to in-stream flows and habitat conditions that maintain or restore riparian resources, favorable channel conditions, and fish passage. Coordinate this process with the appropriate state agencies.*

Survey and Manage The STNF LRMP direction for survey and manage species generally requires protection of known sites and surveys of other areas before ground-disturbing activities. This direction was updated in the *Record of Decision and Standards and Guidelines for Amendments to the Survey and Manage, Protection Buffer, and Related Mitigation Measures Standards and Guideline*s (USFS and BLM 2001). These standards are intended to reduce or eliminate (mitigate) potential effects from agency actions to identified flora and fauna species including mosses, liverworts, fungi, lichens, vascular plants, slugs, snails, salamanders, great gray owl, and red tree voles. This ROD is being implemented consistent with the species list and exceptions identified in the *Settlement Agreement in Litigation over the Survey and Manage Mitigation Measure in Conservation Northwest et al. v. Sherman et al., Case No. 08-1067-JCC* (USFS and BLM 2011). Several known occurrences of survey and manage species occur within the project area, including the Shasta salamander. The STNF LRMP direction requires that most known sites be managed for persistence of the referenced survey and manage species and protected from disturbance during management.

Shasta Snow-Wreath The STNF LRMP supplemental direction that applies to all Sensitive and Endemic plant species, including specific direction pertaining to the Shasta snow-wreath and Scott Mountain fawn lily states:

Search for additional populations of Shasta snow-wreath and Scott Mountain fawn lily. Avoid disturbance pending completion of a conservation strategy.

To date, a conservation strategy has not been developed for the Shasta snow-wreath by USFS.

1.6 Areas of Controversy

Federal, State, and local stakeholders identified several areas of controversy during SLWRI public outreach activities, including public scoping activities, agency meetings, and related ongoing public outreach activities. Major concerns include:

- **Impacts on Cultural Resources –** Sites of cultural and religious significance exist in and around Shasta Lake, including sites related to historical activities of Native Americans. The Winnemem Wintu, a non-federally recognized Native American group, continue to raise concerns about impacts of the original construction of Shasta Dam and potential impacts of enlarging Shasta Dam on sites they value for historical and cultural significance.

  Reclamation has invited Federally recognized tribes and non-Federally recognized Native American groups to be consulting parties to the National Historic Preservation Act Section 106 process. The Winnemem Wintu would continue to have the opportunity to participate, and are anticipated to continue to provide input as an invited consulting party, through the Section 106 process, as well as, through the NEPA process.

- **Impacts on Recreation –** Shasta Lake is the principal recreation destination in Shasta County, which annually realizes well over $160 million related to outdoor recreation. Shasta Lake has attracted development of 9 private marinas with 1,040 houseboats and 18 public campgrounds. Stakeholders are concerned about possible adverse effects on recreation at Shasta Lake, such as inundation impacts on concessionaires and their facilities and related potential impacts on the regional economy.

- **Impacts on McCloud River's Free-Flowing Condition or Wild Trout Fishery –** The McCloud River is not formally designated as either a National or State wild and scenic river; however, Section 5093.542 of the California Public Resources Code includes provisions that are intended to protect the free-flowing condition and wild trout fishery of the McCloud River. Section 5093.542(a) of the California Public Resources Code states that "maintaining the McCloud River in its free-flowing condition to protect its fishery is the highest and most beneficial use of the waters of the McCloud River within the segments designated in subdivision (b).” Section 5093.542(b) prohibits any “dam, reservoir, diversion, or other water impoundment facility ” from 0.25 miles below McCloud Dam downstream to the McCloud River Bridge. Section 5093.542 was established through enactment of the Wild and Scenic Rivers Act, as amended (California Public Resources Code, Sections 5093.50 through 5093.70). Up to about 3,500 feet of the lower McCloud River above the McCloud River Bridge and within the special designation area would be occasionally inundated if Shasta Dam were modified. Thus, action alternatives related to enlargement of Shasta Dam and Reservoir would have some effect on the free-flowing condition of the lower McCloud River and the wild trout fishery within the part of the lower McCloud River protected by Section 5093.542 of the California Public Resources Code. DWR and other State agencies, landowners, and various environmental groups have expressed concerns about potential impacts on McCloud River resources, resulting from enlarging Shasta Dam and Lake.

Additionally, it is possible that State agency participation may be limited for projects that could have an adverse effect on the McCloud River’s free-flowing conditions or its wild-trout fishery. Section 5093.542(c) of the California Public Resources Code states the following:

> *Except for participation by DWR in studies involving the technical and economic feasibility of enlargement of Shasta Dam, no department or agency of the state shall assist or cooperate with, whether by loan, grant, license, or otherwise, any agency of the federal, state, or local government in the planning or construction of any dam, reservoir, diversion, or other water impoundment facility that could have an adverse effect on the free-flowing condition of the McCloud River, or on its wild trout fishery.*

In addition, Section 5093.542(d) of the California Public Resources Code states the following:

> *All state agencies exercising powers under any other provision of law with respect to the protection and restoration of fishery resources shall continue to exercise those powers in a manner to protect and enhance the fishery [of the protected segments of the McCloud River]*.

Participation by various State agencies in planning and potential construction activities associated with modifying Shasta Dam and Reservoir, including related permitting and approval processes, has varied by the agency's mandate and Section 5093.542 of the California Public Resources Code. The California Department of Fish and Wildlife (CDFW, formerly known as the California Department of Fish and Game [CDFG]), has taken the position that it must participate in preparing the EIS to comply with Section 5093.542(d). Other State agencies, including DWR and the State Water Board, have participated to a limited extent or expressed their intent to participate in the SLWRI. The CALFED Program Plan (CALFED 2000b) concluded that although Section 5093.542 seeks to protect the free-flowing condition of the McCloud River, it also provides for investigations of enlarging Shasta Dam. If the preferred alternative or an action alternative is ultimately authorized and approved, it is possible that some State agencies will be unable to process and issue permits and approvals identified above in Table 1-4. This could preclude Reclamation from obtaining State approvals and permits, which could impede a project and frustrate Congressional intent.

In addition, effects to the McCloud River and related provisions in the Public Resources Code are also relevant to the recently passed Proposition 1. California voters approved Proposition 1, "Water Bond. Funding for Water Quality, Supply, Treatment, and Storage Projects," on November 4, 2014, for $7.5 billion, which includes $2.7 billion for storage projects. However, Proposition 1, section 79751 specifies:

> *Projects for which the public benefits are eligible for funding under this chapter consist of only the following:*
>
> *(a) Surface storage projects identified in the CALFED Bay-Delta Program Record of Decision, dated August 28, 2000, except for projects prohibited by Chapter 1.4 (commencing with Section 5093.50) of Division 5 of the Public Resources Code.*

Accordingly, these provisions in Proposition 1 may limit bond funding for a project if the State or its agencies determine that such actions are prohibited by Chapter 1.4 of the Public Resources Code. Section 79751 does not amend or modify the State Public Resources Code. Whether the State of California can use Proposition 1 funds in support of any alternative potentially authorized related to enlargement of Shasta Dam and Reservoir is outside of Reclamation's authority and to be determined by the State of California.

- **Impacts on Reservoir-Area Property Owners –** Raising Shasta Dam would affect privately owned real estate. The raise would: (1) inundate additional lands around Shasta Lake; (2) affect existing structures, requiring acquisition of private property or relocation of displaced parties; and (3) require replacement of bridges and segments of existing paved and unpaved roads. These potential impacts concern property owners around Shasta Lake.

- **Impacts on the Environment, Especially Biological Resources –** Raising Shasta Dam or modifying project operations would affect a broad range of environmental resources, some adversely and some beneficially. Concern has been expressed about potential impacts on all of the following:

  – Wildlife habitat, special-status plant and animal species, and State-designated fully protected species along the shoreline

  – Fishery habitat on several creeks and streams that flow into Shasta Lake

  – Fishery and riparian habitat resources along the upper Sacramento River below Shasta Dam

  – Delta smelt and other sensitive aquatic species in the Delta

  – Delta water quality and south Delta water levels

  – Central Valley hydrology below CVP and SWP facilities, and resulting effects on water supplies for water contractors and other water users.

- **CVP and SWP Operational Assumptions –** Operational constraints for the CVP and SWP are affected by changing regulatory conditions in California. For this EIS, CVP and SWP operational assumptions were based on operations described in Reclamation's 2008 Long-Term Operation BA, the 2008 USFWS BO, the 2009 NMFS BO, and the Coordinated Operations Agreement between Reclamation and DWR, as ratified by Congress. However, the ongoing remand processes for the 2008 USFWS and 2009 NMFS BOs have resulted in some uncertainty about future CVP and SWP operational constraints.

1.7 Documents Used to Prepare EIS

This EIS considers and relies on the assessments in the *CVPIA Final* PEIS (Reclamation 1999b) and CALFED Final PEIS/R (CALFED 2000b). In addition, the CVPIA and the overall goals and objectives of CALFED were considered throughout the SLWRI study process.

1.7.1 CVPIA EIS

The CVPIA is a Federal statute enacted in 1992 with the following purposes:

> *To protect, restore, and enhance fish, wildlife, and associated habitats in the Central Valley and Trinity River basins of California; to address impacts of the CVP on fish, wildlife and associated habitats; to improve the operational flexibility of the CVP; to increase water-related benefits provided by the CVP to the state of California through expanded use of voluntary water transfers and improved water conservation; to contribute to the state of California's interim and long-term efforts to protect the Bay-Delta; and to achieve a reasonable balance among competing demands for use of CVP water, including the requirements of fish and wildlife, agricultural, municipal and industrial and power contractors.*

A Final PEIS (Reclamation 1999b) was prepared by Reclamation and USFWS in October 1999 to address the potential impacts of implementing the CVPIA. Although not tiering to that document, this EIS uses information contained in the CVPIA PEIS, updated to reflect current and project-specific conditions.

1.7.2 CALFED PEIS/R

CALFED is a collaboration of numerous Federal and State agencies with regulatory and management responsibilities in the Bay-Delta to develop and implement a long-term comprehensive plan to restore ecological health and improve water management for beneficial uses of the Bay-Delta system. The objective of the collaborative planning process is to identify comprehensive solutions to the problems of ecosystem quality, water delivery reliability, water quality, and Delta levee integrity.

In July 2000, the CALFED agencies released the Final PEIS/R (CALFED 2000b), which analyzed a range of alternatives to solve Bay-Delta system problems. In August 2000, the CALFED agencies issued the CALFED Programmatic ROD which identified 12 action plans. Specifically, plans were identified for the Governance, Ecosystem Restoration, Watersheds, Water Supply Reliability, Storage, Conveyance, Environmental Water Account, Water Use Efficiency, Water Quality, Water Transfer, Levees, and Science programs (CALFED 2000a). The CALFED agencies then began implementing Stage 1 of the Programmatic ROD, including the first 7 years of a 30-year program to establish a foundation for long-term actions. The SLWRI studies to-date and this associated EIS are consistent with applicable components of the CALFED PEIS/R, and the SLWRI EIS tiers to that PEIS/R.

1.8 Organization of EIS

Chapter 1, "Introduction," summarizes the purpose, need, objectives, authorization, and location of the proposed action; provides an overview of the environmental review process and background for the project; summarizes the intended use of the EIS and areas of controversy, and discusses documents used to prepare this EIS.

Chapter 2, "Alternatives," summarizes the methods used for selecting alternatives, describes the project alternatives, discusses alternatives that have been eliminated from further discussion, and describes the preferred alternative.

Chapter 3, "Considerations for Describing Affected Environment and Environmental Consequences," describes the approach to describing the affected environment and environmental consequences, defines impact levels, and describes the methodology for cumulative effects, including projects considered in the cumulative effects analysis. This chapter also presents the regulatory framework for the resource chapters that follow.

Chapters 4 – 25 describe the existing environmental and resource-specific regulatory frameworks for each resource area analyzed in this EIS, in the following order:

- **Chapter 4, "Geology, Geomorphology, Minerals, and Soils"**
- **Chapter 5, "Air Quality and Climate"**
- **Chapter 6, "Hydrology, Hydraulics, and Water Management"**
- **Chapter 7, "Water Quality"**
- **Chapter 8, "Noise and Vibration"**
- **Chapter 9, "Hazards and Hazardous Materials and Waste"**
- **Chapter 10, "Agriculture and Important Farmland"**
- **Chapter 11, "Fisheries and Aquatic Ecosystems"**
- **Chapter 12, "Botanical Resources and Wetlands"**
- **Chapter 13, "Wildlife Resources"**
- **Chapter 14, "Cultural Resources"**
- **Chapter 15, "Indian Trust Assets"**
- **Chapter 16, "Socioeconomics, Population, and Housing"**

- **Chapter 17, “Land Use and Planning”**
- **Chapter 18, “Recreation and Public Access”**
- **Chapter 19, “Aesthetics and Visual Resources”**
- **Chapter 20, “Transportation and Traffic”**
- **Chapter 21, “Utilities and Service Systems”**
- **Chapter 22, “Public Services”**
- **Chapter 23, “Power and Energy”**
- **Chapter 24, “Environmental Justice”**
- **Chapter 25, “Wild and Scenic River Considerations for McCloud River”**

Each resource chapter listed above also describes project-level impacts of the No-Action Alternative and action alternatives on the resource or issue area, mitigation measures for those impacts, and cumulative effects of all of the alternatives.

Chapter 26, “Other Required Disclosures,” describes any significant adverse effects of the project that cannot be avoided, irreversible and irretrievable commitments of resources, growth-inducing effects, and compliance with applicable laws.

Chapter 27, “Public Involvement, Consultation, and Coordination,” describes the public scoping process, agencies and organizations consulted, and areas of controversy, and identifies issues to be resolved.

Chapter 28, “DEIS Distribution List,” lists the elected officials; government departments; Federal, State, and local agencies; and interested parties that received notice of the availability of the SLWRI DEIS.

Chapter 29, “List of EIS Preparers,” lists individuals who participated in preparation of this EIS, and provides the qualifications of those individuals, in order of organization and agency.

Chapter 30, “References,” lists the sources of information used to prepare this EIS.

Chapter 31, “Index,” lists important terms and topics and gives page numbers of relevant discussions.

Chapter 32, "Final EIS," provides an overview of the Final EIS, including public involvement and consultation and coordination efforts for the EIS, a description of the preferred alternative, document availability and distribution, and next steps.

Chapter 33, "Public Comments and Responses," contains the comments received on the DEIS and responses to those comments.

Chapter 2 Alternatives

NEPA and CEQA require consideration of the potential effects of a range of action alternatives that would feasibly attain the majority of a project's basic objectives and accomplish the specified project purpose and need, while avoiding and/or minimizing adverse environmental impacts, in addition to the No-Action Alternative (which also constitutes the No-Project Alternative under CEQA). The purpose of including alternatives in an EIS is to offer a clear basis for choice by decision makers and the public about whether to proceed with a proposed action or project.

NEPA requires that alternatives be evaluated at a comparable level of detail (Title 40, Code of Federal Regulations (CFR) Part 1502.14(b)). Similarly, the Council on Environmental Quality (CEQ) regulations for implementing NEPA (Title 40, CFR Part 1502.14) require a range of reasonable alternatives to be objectively evaluated in an EIS so that each alternative is evaluated at an equal level of detail. Alternatives that cannot reasonably meet the project purpose and need do not require detailed analysis.

CEQA requires that the lead agency consider alternatives that would avoid or reduce one or more of the significant impacts identified for a project in an EIR. The State CEQA Guidelines state that an EIR needs to describe and evaluate only those alternatives necessary to permit a reasonable choice and to foster informed decision making and informed public participation (Section 15126.6(f)). Consideration of alternatives focuses on those that can either eliminate significant adverse environmental impacts, or reduce them to less-than-significant levels; alternatives considered in this context may include those that are more costly, and those that could impede, to some degree, the attainment of all the project objectives (Section 15126.6(b)). CEQA does not require the alternatives to be evaluated at the same level of detail as a proposed project.

NEPA and CEQA require consideration of future conditions No-Action/No Project Alternative as a basis of comparison with the action alternatives.

This chapter documents compliance with NEPA requirements for alternatives analysis and the alternatives development process, and describes the action alternatives evaluated in detail in this EIS. This chapter was also generally prepared in consideration of CEQA requirements. This chapter includes the following sections:

- **Section 2.1, Alternatives Development Process**, describing the overall plan formulation process and phases for the SLWRI, project objectives, planning constraints and considerations, management measures, and development and refinement of alternatives.

- **Section 2.2, No-Action Alternative**, describing the No-Action/No Project Alternative, representing a scenario in which a project is not implemented.

- **Section 2.3, Action Alternatives**, describing the comprehensive plans (action alternatives) evaluated in this EIS, including major components, potential benefits, operations and maintenance, and physical features/construction activities for each action alternative.

- **Section 2.4, Alternatives Considered and Eliminated from Further Analysis**, describing alternatives considered but eliminated from further development and consideration during formulation of initial alternatives and comprehensive plans.

- **Section 2.5, Summary of Potential Benefits of Action Alternatives**, summarizing the major potential benefits of proposed comprehensive plans (action alternatives).

- **Section 2.6, Preferred Alternative and Rationale for Selection**, describing the basis for selecting a plan for recommendation, including the criteria and considerations used in selecting a recommended course of action by the Federal Government.

2.1 Alternatives Development Process

This section describes the alternatives development process for the SLWRI. A more detailed description of this process is included in the Plan Formulation Appendix.

The SLWRI is one of five surface water storage studies recommended in the 2000 CALFED Bay-Delta Program (CALFED) Programmatic Environmental Impact Statement/Environmental Impact Report (PEIS/R) Preferred Program Alternative and associated Programmatic Record of Decision (ROD). As described in Chapter 1, "Introduction," consistent with guidance in the CALFED Programmatic ROD, the SLWRI EIS tiers to the CALFED PEIS/R. Preliminary studies in support of the CALFED PEIS/R considered more than 50 surface water storage sites throughout California and recommended more detailed study of the five sites identified in the CALFED Programmatic ROD (CALFED 2000a, 2000b, 2000c). The CALFED Programmatic ROD states that:

> *Tiered documents focus on issues specific to the subsequent action and rely on the analysis of issues already decided in the broader programmatic review. Absent new information or substantially changed circumstances, documents tiering from the CALFED Final Programmatic EIS/R will not revisit the alternatives that were considered alongside CALFED's Preferred Program Alternative nor will they revisit alternatives that were rejected during CALFED's alternative development process.*

Consistent with this guidance, the SLWRI EIS relies on the evaluations and alternatives development and screening included in the CALFED PEIS/R, and focuses on the subsequent action of evaluating the enlargement of Shasta Lake.

2.1.1 Plan Formulation Process

Consistent with NEPA, the plan formulation process for Federal water resources studies and projects identified in the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (P&G) (WRC 1983) begins with identifying existing and projected future resources conditions likely to occur in a study area. This is followed by defining water resources problems, needs, and opportunities to be addressed, and developing planning objectives, constraints, and criteria.

For the SLWRI, the above process was separated into five phases, all of which have been completed. These planning phases are shown in Figure 2-1 and described below:

- **Mission Statement Phase –** This study phase consisted of projecting without-project future conditions, defining resulting resource problems and needs, defining a specific set of planning objectives, and identifying constraints and criteria for addressing the planning objectives. These activities were documented in the 2003 *SLWRI Mission Statement Milestone Report*.

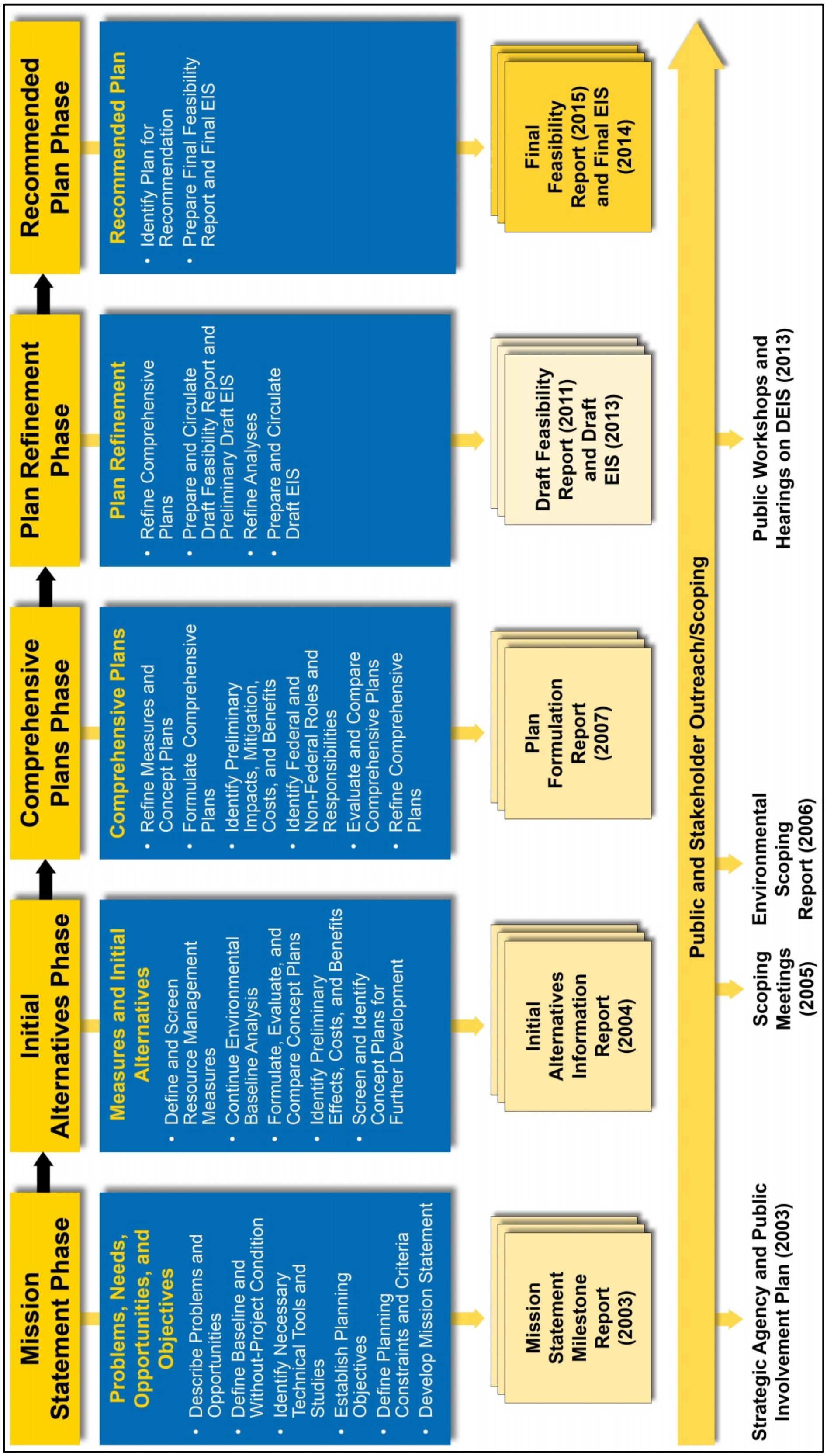
- **Initial Alternatives Phase –** This phase included developing a number of potential management measures, or project actions or features designed to address planning objectives. These measures were then used to formulate a set of plans that were conceptual in scope (concept plans). These initial plans were evaluated and compared to the planning objectives to identify the most suitable plans for further development. This phase concluded with the release of the 2004 *SLWRI Initial Alternatives Information Report* describing the formulation and evaluation of management measures and initial plans.

- **Comprehensive Plans Phase –** The measures and concept plans carried forward were further refined and developed with more specificity to formulate comprehensive alternative plans to address the planning objectives. These plans were then evaluated and compared. This phase included the release of the 2007 *SLWRI Plan Formulation Report* describing the formulation, evaluation, and comparison of comprehensive plans.

- **Plan Refinement Phase –** This phase focused on further refinement and iterative evaluation of the potential effects of the comprehensive plans. This phase included preparing and circulating a Draft Feasibility Report, which was completed in November 2011 and released to the public in February 2012, and the DEIS, which was released to the public in June 2013 for public review and comment.

- **Recommended Plan Phase –** This phase of the SLWRI planning process focuses on identifying a plan for recommendation and preparing and processing the Final Feasibility Report, to support a Federal decision, and this Final EIS.

Public and stakeholder outreach was performed concurrently with the above phases, as shown in Figure 2-1. Major reports include the *SLWRI Strategic Agency and Public Involvement Plan*, published in 2003 (Reclamation), and the *SLWRI Environmental Scoping Report*, published in 2006 (Reclamation).



Key: DEIS = Draft Environmental Impact Statement   EIS = Environmental Impact Statement

Figure 2-1. Plan Formulation Phases

2.1.2 Project Objectives

On the basis of the problems, needs, and opportunities identified in the plan formulation process, study authorities, and other pertinent direction, including information contained in the CALFED PEIS/R and Programmatic ROD (CALFED 2000a, 2000b), primary and secondary project objectives (also referred to as planning objectives) were developed. Primary objectives are those which specific alternatives are formulated to address. The primary objectives are considered to have equal priority, with each pursued to the maximum practicable extent without adversely affecting the other. Secondary objectives are considered to the extent possible through pursuit of the primary objectives.

- **Primary Objectives**:
  - Increase the survival of anadromous fish populations in the Sacramento River, primarily upstream from the Red Bluff Pumping Plant (RBPP)
  - Increase water supply and water supply reliability for agricultural, municipal and industrial (M&I), and environmental purposes to help meet current and future water demands, with a focus on enlarging Shasta Dam and Reservoir
- **Secondary Objectives**:
  - Conserve, restore, and enhance ecosystem resources in the Shasta Lake area and along the upper Sacramento River
  - Reduce flood damage along the Sacramento River
  - Develop additional hydropower generation capabilities at Shasta Dam
  - Maintain and increase recreation opportunities at Shasta Lake
  - Maintain or improve water quality conditions in the Sacramento River downstream from Shasta Dam and in the Delta

2.1.3 Planning Constraints and Other Considerations

The P&G provides fundamental guidance for the formulation of Federal water resources projects. In addition, basic constraints and considerations specific to this investigation were developed and identified. Following is a summary of the constraints and considerations relevant to the SLWRI.

Planning Constraints

Planning constraints help guide the plan formulation process. Some planning constraints are more rigid than others. Examples of more rigid constraints include congressional direction in study authorizations; other current applicable laws, regulations, and policies; and physical conditions (e.g., topography, hydrology). Other planning constraints are less restrictive but are still influential in guiding the process. Several key constraints identified for the SLWRI are as follows:

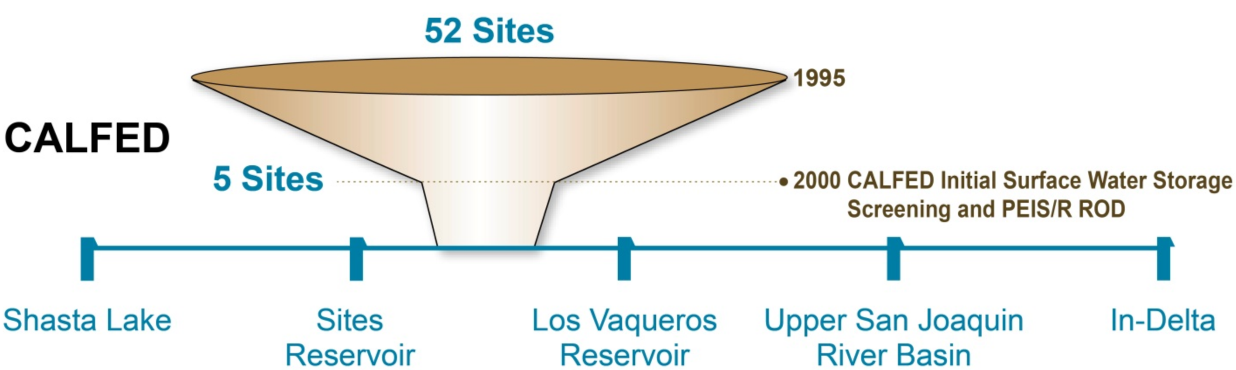
- **Study Authorizations –** On August 30, 1935, in the Rivers and Harbors Bill, an initial amount of Federal funds was authorized for constructing Kennett (now Shasta) Dam. Initial authorization for the SLWRI derives from Public Law 96-375 of 1980. This law authorized the Secretary of the Interior to engage in feasibility studies relating to (1) enlarging Shasta Dam and Reservoir, or constructing a replacement dam on the Sacramento River and (2) using the Sacramento River to convey water from an enlarged dam. Additional guidance is contained in Public Law 108-361 of 2004, which authorized the Secretary of the Interior to carry out "…planning and feasibility studies for projects to be pursued with project-specific study for enlargement of the Shasta Dam in Shasta County…"

- **CALFED PEIS/R and Programmatic ROD –** CALFED was established to "develop and implement a long-term comprehensive plan that would restore ecological health and improve water management for beneficial uses of the San Francisco Bay/Sacramento-San Joaquin Delta (Bay-Delta) system." The 2000 CALFED PEIS/R and Programmatic ROD (CALFED 2000a, 2000b) include program goals, objectives, and projects primarily to benefit the Bay-Delta system. The objectives for the SLWRI are consistent with the CALFED Programmatic ROD (CALFED 2000a) for Shasta enlargement, as follows:

  > *Expand CVP storage in Shasta Lake by approximately 300,000 acre-feet. Such an expansion will increase the pool of cold water available to maintain lower Sacramento River temperatures needed by certain fish and provide other water management benefits, such as water supply reliability.*

  The CALFED Programmatic ROD has been adopted by various Federal and State of California (State) agencies as a framework for further consideration. In addition to objectives for potential enlargement of Shasta Dam and Reservoir, the Preferred Program Alternative in the CALFED PEIS/R and Programmatic ROD includes four other potential surface water and various groundwater storage projects to help reduce the gap between water supplies and projected demands. Expanding water storage capacity is critical to the successful implementation of all aspects of the program. Water supply reliability rests on capturing peak flows, especially during wet years. New storage must be strategically located to provide the needed flexibility in the current water system to improve water quality, support fish restoration goals, and meet the needs of a growing population. The CALFED Programmatic ROD also includes numerous other projects to help improve the ecosystem functions of the Bay-Delta system. Developed plans should address the goals, objectives, and programs and projects of the CALFED PEIS/R and Programmatic ROD (CALFED 2000a, 2000b).

CALFED conducted an initial screening of a list of 52 potential surface water storage sites to reduce the number of sites to a more manageable number for more detailed evaluation during project-specific studies (2000b). CALFED eliminated sites providing less than 200,000 acre-feet storage and those that conflicted with CALFED solution principles, objectives, or policies. Further, based on existing information, CALFED identified some potential surface water storage sites that were more promising in contributing to CALFED goals and objectives and more implementable due to relative costs and stakeholder support. Surface water storage sites recommended by CALFED for subsequent evaluation focused on those with the most potential for helping meet CALFED goals and objectives: Shasta Lake Enlargement, Los Vaqueros Reservoir Enlargement, Sites Reservoir, In-Delta Storage, and development of storage in the upper San Joaquin River Basin (CALFED 2000b) (Figure 2-2).



Key:
CALFED = CALFED Bay-Delta Program
Delta = Sacramento-San Joaquin Delta
PEIS/R = Program Environmental Impact Statement/Report
ROD = Record of Decision

Figure 2-2. CALFED Surface Water Storage Investigations Screening

- **Laws, Regulations, and Policies** – Numerous laws, regulations, executive orders, and policies need to be considered, among them: the P&G, NEPA, Fish and Wildlife Coordination Act, Federal Clean Air Act (CAA), Federal Clean Water Act (CWA), National Historic Preservation Act (NHPA), California Public Resources Code, Federal and State Endangered Species Acts, CEQA, and Central Valley Project Improvement Act (CVPIA). The CVPIA, including the associated

Anadromous Fish Restoration Program, is pertinent because it identified specific actions for fish and wildlife mitigation, protection, restoration, and enhancement which influence water supply deliveries, river flows, and related environmental conditions in the primary and extended study areas.

- Table 1-5 in the Plan Formulation Appendix summarizes many of the applicable laws, policies, plans, and permits potentially affecting the project.

Planning Considerations

Planning considerations were specifically identified to help formulate, evaluate, and compare initial plans and, later, detailed alternatives:

- Alternatives should incorporate results of coordination with other Federal and State agencies such as the USFWS; NMFS; USFS; U.S. Department of Interior, Bureau of Indian Affairs; U.S. Department of Interior, Bureau of Land Management (BLM); DWR; and CDFW.
- A direct and significant geographical, operational, and/or physical dependency must exist between major components of alternatives.
- Alternatives should address, at a minimum, each of the identified primary planning objectives and, to the extent possible, the secondary planning objectives.
- Measures to address secondary planning objectives should be either directly or indirectly related to the primary planning objectives (i.e., plan features should not be independent increments).
- Alternatives should strive to first avoid potential adverse effects to environmental resources, or then should include features to mitigate for unavoidable adverse effects through enhanced designs, construction methods, and/or facilities operations.
- Alternatives should avoid any increases in flood damage or other significant, adverse hydraulic effects to areas downstream along the Sacramento River.
- Alternatives should strive to first avoid potential adverse effects to present or historical cultural resources, or then include features to mitigate unavoidable adverse effects.
- Alternatives should not result in significant adverse effects to existing and future water supplies, hydropower generation, or related water resources conditions.

- Alternatives should strive to balance increased water supply reliability between agricultural and M&I uses.
- Alternatives should not result in a reduction in existing recreation capacity at Shasta Lake.
- Alternatives are to consider the purposes, operations, and limitations of existing projects and programs and be formulated to not adversely impact those projects and programs.
- Alternatives are to be formulated and evaluated based on a 100-year period of analysis.
- Construction costs for alternatives are to reflect current prices and price levels, and annual costs are to include the current Federal discount rate and an allowance for interest during construction.
- Alternatives are to be formulated to neither preclude nor enhance development and implementation of other elements included in the CALFED Programmatic ROD or other water resources programs and projects in the Central Valley.
- Alternatives should have a high certainty for achieving intended benefits and not significantly depend on long-term actions (past the initial construction period) for success. Alternatives that require future and ongoing action specific for success have a higher uncertainty than other plans.

2.1.4 Management Measures

Following development of objectives, constraints, and other considerations for the SLWRI, the next major step in plan formulation was to identify and evaluate potential management measures. A management measure is any structural or nonstructural project action or feature that could address the objectives and satisfy the other applicable planning considerations. Numerous potential management measures were identified based on coordination with agencies, public and stakeholder outreach activities, and previous studies, programs, and projects. These measures were developed through SLWRI study team meetings, field inspections, outreach, and environmental scoping for the SLWRI. Management measures are listed in Table 2-1 and described in detail in the Plan Formulation Appendix.

Table 2-1. Management Measures to Address Objectives

Objectives		Management Measure	Retained	Deleted
		Primary Objectives		
Increase Anadromous Fish Survival	Improve Fish Habitat	Restore abandoned gravel mines along the Sacramento River		X
		Construct instream aquatic habitat downstream from Keswick Dam	X	
		Replenish spawning gravel in the Sacramento River	X	
		Construct instream fish habitat on tributaries to the Sacramento River		X
		Remove instream sediment along Middle Creek		X
		Rehabilitate inactive instream gravel mines along Stillwater and Cottonwood creeks		X
	Improve Water Flows and Quality	Make additional modifications to Shasta Dam for temperature control	X	
		Enlarge Shasta Lake cold-water pool	X	
		Modify storage and releases operations at Shasta Dam	X	
		Modify ACID diversions to reduce flow fluctuations		X
		Increase instream flows on Clear, Cow, and Bear creeks		X
		Construct a storage facility on Cottonwood Creek to augment spring instream flows		X
		Transfer existing Shasta Reservoir storage from water supply to cold-water releases		X
		Remove Shasta Dam and Reservoir		X
	Improve Fish Migration	Improve fish trap below Keswick Dam		X
		Screen diversions on Old Cow and South Cow creeks		X
		Remove or screen diversions on Battle Creek		X
		Construct a migration corridor from the Sacramento River to the Pit River		X
		Cease operating or remove the Red Bluff Diversion Dam		X
		Reoperate the CVP to improve overall fish management		X
		Construct a fish ladder on Shasta Dam		X
		Reintroduce anadromous fish to areas upstream from Shasta Dam		X
Increase Water Supply Reliability	Increase Surface Water Storage	Increase conservation storage space in Shasta Reservoir by raising Shasta Dam	X	
		Construct new conservation storage reservoir(s) upstream from Shasta Reservoir		X
		Construct new conservation storage on tributaries to the Sacramento River downstream from Shasta Dam		X
		Construct new conservation offstream surface storage near the Sacramento River downstream from Shasta Dam		X
		Construct new conservation surface water storage south of the Delta		X
		Increase total or seasonal conservation storage at other CVP facilities		X
		Dredge bottom of Shasta Reservoir		X

Table 2-1. Management Measures to Address Objectives (contd.)

Objectives		Management Measure	Retained	Deleted
Increase Water Supply Reliability (continued)	Reoperate Reservoir	Increase effective conservation storage space in Shasta Reservoir by increasing efficiency of reservoir operation for water supply reliability	X	
		Increase the conservation pool in Shasta Reservoir by encroaching on dam freeboard		X
		Increase conservation storage space in Shasta Reservoir by reallocating space from flood control		X
	Improve Conjunctive Water Management	Develop conservation offstream surface storage near the Sacramento River downstream from Shasta Dam		X
		Develop conservation groundwater storage near the Sacramento River downstream from Shasta Dam		X
		Develop additional conservation groundwater storage south of the Delta		X
	Coordinate Operation and Precipitation Enhancement	Improve Delta export and conveyance capability through coordinated CVP and SWP operations		X
		Implement additional precipitation enhancement		X
	Reduce Demand	Implement water use efficiency methods	X	
		Retire agricultural lands		X
	Improve Water Transfers and Purchases	Transfer water between users		X
	Expand Delta Export and Conveyance Facilities	Expand Banks Pumping Plant		X
		Construct Delta-Mendota Canal/California Aqueduct intertie		X
	Improve Surface Water Treatment	Implement treatment/supply of agricultural drainage water		X
		Construct desalinization facility		X

Table 2-1. Management Measures to Address Objectives (contd.)

Objectives		Management Measure	Retained	Deleted
Secondary Objectives				
Conserve, Restore, and Enhance Ecosystem Resources	Improve Cold-Water and Warm-Water Fishery Habitat	Construct shoreline fish habitat around Shasta Lake	X	
		Construct instream fish habitat on tributaries to Shasta Lake	X	
		Increase instream flows on the lower McCloud River		X
		Reduce acid mine drainage entering Shasta Lake		X
		Reduce motorcraft access to upper reservoir arms		X
		Increase instream flows on the Pit River		X
	Restore and Conserve Riparian and Wetland Habitat	Restore riparian and floodplain habitat along the Sacramento River	X	
		Restore wetlands along the Fall River and Hat Creek		X
		Conserve upper Pit River riparian areas		X
		Restore riparian and floodplain habitat on lower Clear Creek		X
		Promote Great Valley cottonwood regeneration along the Sacramento River		X
		Conserve riparian corridor along Cow Creek		X
		Remove and control nonnative vegetation in the Cow Creek and Cottonwood Creek watersheds		X
	Improve Other Fish and Wildlife Habitat	Create a parkway along the Sacramento River		X
		Enhance forest management practices to conserve bald eagle nesting habitat		X
		Remove and control nonnative plants around Shasta Lake		X
		Control erosion and restore affected habitat in the Shasta Lake area		X
		Develop geographic information system for Shasta to Red Bluff reach		X
		Implement erosion control in tributary watersheds		X
Reduce Flood Damage		Update Shasta Dam and Reservoir flood management operations	X	
		Increase flood management storage space in Shasta		X
		Implement nonstructural flood damage reduction measures		X
		Implement traditional flood damage reduction measures		X
		Route PMF from top of conservation pool		X

Table 2-1. Management Measures to Address Objectives (contd.)

Objectives	Management Measure	Retained	Deleted
Develop Additional Hydropower Generation	Modify existing/construct new generation facilities at Shasta Dam to take advantage of increased hydraulic head	X	
	Construct new hydropower generation facilities		X
Maintain and Increase Recreation Opportunities	Maintain and enhance recreation capacity, facilities, and opportunities	X	
	Develop new NRA recreation plan		X
	Reoperate reservoir for recreation	X	
Maintain or Improve Water Quality	Improve operational flexibility for Delta water quality by increasing storage in Shasta Reservoir	X	

Key:
ACID = Anderson-Cottonwood Irrigation District
Banks Pumping Plant = Harvey O. Banks Pumping Plant
CVP = Central Valley Project
Delta = Sacramento-San Joaquin Delta
NRA = National Recreation Area
PMF = probable maximum flood
SWP = State Water Project

In the context of SLWRI management measures and project actions, the term "enhancement" specifically refers to restoration actions that improve environmental conditions above the baseline (without-project condition). Correspondingly, the term "mitigation" refers to restoration actions that improve environmental conditions toward the baseline to compensate for unavoidable adverse project impacts. The relationship between enhancement and mitigation is illustrated in Figure 2-3.

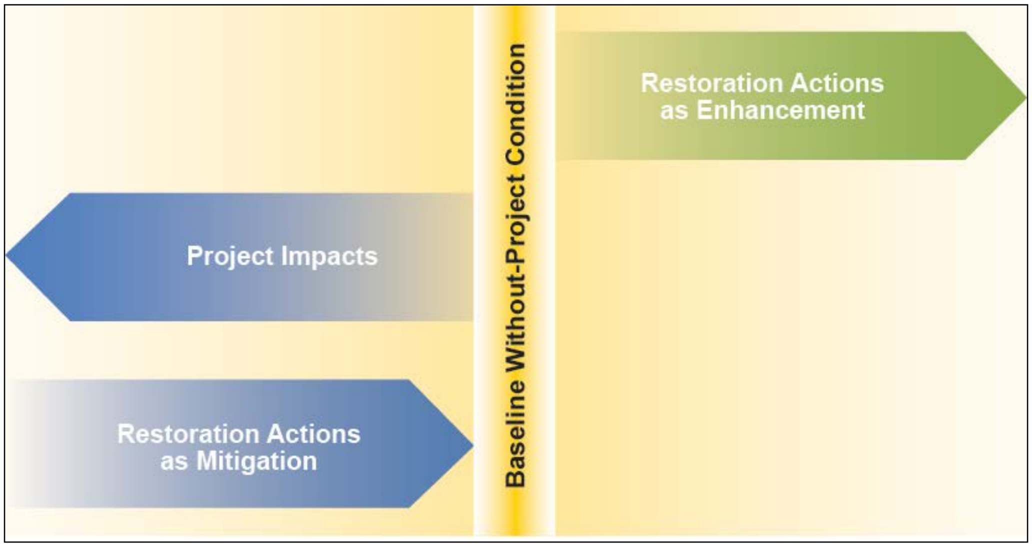


Figure 2-3. Conceptual Schematic of Restoration Actions as Enhancement Versus Restoration Actions as Mitigation

The SLWRI study team and stakeholders reviewed the management measures for their ability to address the primary and secondary objectives. Retained management measures were combined to formulate concept plans. As detailed in the Plan Formulation Appendix, measures were retained for possible inclusion in an alternative plan or deleted from further consideration for various reasons. One important factor for retention in alternative plans was the potential for a measure to directly address an objective without adversely impacting other objectives.

Of the management measures listed in Table 2-1, eight measures addressing primary objectives were selected for further consideration and potential inclusion in alternative plans. In addition, eight measures addressing secondary objectives were also selected for potential inclusion in alternative plans. Measures that have been carried forward are believed to best address the project objectives, with consideration of planning constraints and criteria.

2.1.5 Initial Alternatives Phase

The retained measures were used to formulate a preliminary set of plans that were conceptual in scope. Each concept plan was reviewed for impacts, costs, and benefits and compared to objectives to determine whether the plan should be eliminated or carried forward into the comprehensive plans phase. The purpose of this phase of the formulation process was to (1) explore an array of different strategies to address the primary objectives, constraints, and criteria, and (2) identify concept plans that would warrant further development in the comprehensive plans phase.

First, two sets of plans were developed that focused on either anadromous fish survival (AFS) or water supply reliability (WSR) as the single primary objective. Three AFS plans and four WSR plans were developed. Although the AFS and WSR plans focused on single objectives, each generally contributed to both primary objectives. In the three AFS plans, for example, emphasis was placed on combinations of measures that could best address the fish survival goals while considering incidental benefits to water supply reliability, if possible. Second, five plans were developed that included measures to address both primary and, to a lesser degree, secondary objectives, termed combined objective (CO) plans. All 12 concept plans are listed in Table 2-2, and are explained in detail in the Plan Formulation Appendix.

The 12 concept plans were compared considering two basic planning criteria: effectiveness and efficiency. Effectiveness is the extent to which an alternative alleviates problems and achieves objectives; efficiency is the measure of how efficiently an alternative alleviates identified problems and meets specified objectives to protect the nation's environment. These, along with completeness and acceptability, are the four general criteria identified in the P&G (WRC 1983). Based on this comparison, and the relative ability of plans to address both primary objectives, five of the concept plans were initially recommended for further development as comprehensive plans: WSR-1, WSR-2, WSR-4, CO-2, and CO-5. None of the AFS plans were recommended for further development because AFS-1 did not contribute to the primary objective of increasing water supply reliability, and evaluations indicated that AFS-2 and AFS-3 would result in fewer benefits to anadromous fish survival than any of the WSR and CO plans. This is because AFS-2 and AFS-3 focused on increasing minimum flows in the upper Sacramento River, which resulted in a reduced cold-water pool during drought periods in comparison to WSR and CO plans.

Through subsequent evaluations, CO-2 was also eliminated from further consideration because it was concluded that restoration of existing gravel mines would have a low efficiency and likelihood of successfully benefiting salmon resources. Subsequent analysis of WSR-4 and the conjunctive use component of CO-5 indicated tradeoffs between conjunctive use water supply benefits and critical gains in fisheries benefits. The resulting reduction in benefits to fisheries operations in dry and critical years[1] was deemed unacceptable in terms of

[1] Throughout this document, water year types are defined according to the Sacramento Valley Index Water Year Hydrologic Classification unless specified otherwise.

meeting primary project objectives. Thus, WSR-4 and the conjunctive use component of CO-5 were eliminated from further consideration.

Table 2-2. Summary of Concept Plan Features

Plan	Features												
	Dam Raise	Primary Objective Focus							Secondary Objectives Addressed[4]				
		Water Supply Reliability[2]		Anadromous Fish Survival					Environmental Restoration			Flood Control and Hydropower	
		Increase Conservation Storage	Perform Conjunctive Water Management[3]	Reoperate Shasta Dam	Modify TCD	Replenish Spawning Gravel	Enlarge Shasta Lake Cold-Water Pool	Increase Minimum Flows[3]	Restore Shoreline Aquatic Habitat	Restore Tributary Aquatic Habitat	Restore Riparian Habitat	Modify Flood Control Operations and Implement Shasta Public Safety[3] Features	Modify Hydropower Facilities
AFS-1	6.5	*		Changes to water supply operations and modification of the TCD would likely be included, to some extent, in any alternative that includes raising Shasta Dam.			X					Changes to flood control operations at Shasta Dam, Public Safety,[3] and hydropower facilities would likely be part of any alternative that includes physically modifying Shasta Dam; the degree and details of these changes will be included in feasibility level alternative plans.	
AFS-2	6.5	*					*	X					
AFS-3	6.5	*				X	*	X					
WSR-1	6.5	X					*						
WSR-2	18.5	X					*						
WSR-3	202.5	X					*						
WSR-4	18.5	X	X				*						
CO-1	6.5	X				X	X						
CO-2	18.5	X				X	X						
CO-3	18.5	X				X	X	X					
CO-4	6.5	X	X			X	X		X	X	X		
CO-5	18.5	X	X			X	X		X	X	X		

Notes:

[1] Raising Shasta Dam provides both water supply and temperature benefits, regardless of how the additional storage is exercised. While the anadromous fish survival measures focus on use of the additional space for anadromous fish survival, they also provide water supply benefits. Similarly, the water supply reliability measures focus on water supply reliability but the reservoir enlargements also provide benefits to anadromous fish.

[2] All concept plans include water demand reduction.

[3] These measures were used for evaluation because they were retained at the time of plan formulation. However, they have since been removed from consideration.

[4] Water quality and recreation were added as secondary objectives after development of concept plans, and are not considered in this table.

Key:
* Coincidental benefit, although not a primary focus of the concept plan.
AFS-x = anadromous fish survival
CO-x = combined objectives
TCD = temperature control device
WSR-x = water supply reliability
X = Primary focus of concept plan

The eight concept plans eliminated from further consideration are described in Section 2.4, “Alternatives Considered and Eliminated from Further Analysis.” Although these concept plans were not further considered as stand-alone plans, major features of some of these plans were refined for further development into alternatives. Concept plans eliminated from further consideration, and rationale for their elimination, are discussed in greater detail in the Plan Formulation Appendix.

2.1.6 Development and Refinement of Comprehensive Plans

Through continued refinement of management measures and concept plans carried forward, the following plan types were identified for further development into comprehensive plans:

- Plan(s) to raise Shasta Dam between 6.5 feet and 18.5 feet, focusing on both water supply reliability and anadromous fish survival but with benefits to various secondary objectives
- Plan(s) to raise Shasta Dam by about 18.5 feet, focusing on anadromous fish survival, but also including water supply reliability and other various secondary objectives
- Plan(s) to raise Shasta Dam by about 18.5 feet, focusing on all objectives

Considering results of initial plan formulation efforts, the approach was to first formulate plans focusing on different dam raise heights within the range of 6.5 feet to 18.5 feet to address the first plan type listed above. A dam raise of 12.5 feet was chosen because it represented a midpoint between the smallest and largest practical dam raises. Next, the approach was to identify the most efficient and effective of the identified dam raise heights, and formulate comprehensive plans to focus on anadromous fish survival and other objectives at this height.

Comprehensive Plans in the Draft Feasibility Report and Supporting Documents

Using the general rationale described above, and incorporating input from the public scoping process and continued coordination with resource agencies and other interested parties, five comprehensive plans were developed for the Draft Feasibility Report and Preliminary DEIS:

- **Preliminary Comprehensive Plan 1 (PCP1) –** 6.5-foot dam raise, enlarging the reservoir by 256,000 acre-feet, focusing on both anadromous fish survival and water supply reliability.
- **Preliminary Comprehensive Plan 2 (PCP2) –** 12.5-foot dam raise, enlarging the reservoir by 443,000 acre-feet, focusing on both anadromous fish survival and water supply reliability.

- **Preliminary Comprehensive Plan 3 (PCP3) –** 18.5-foot dam raise, enlarging the reservoir by 634,000 acre-feet, focusing on both anadromous fish survival and water supply reliability.

- **Preliminary Comprehensive Plan 4 (PCP4) –** 18.5-foot dam raise, enlarging the reservoir by 634,000 acre-feet, focusing on anadromous fish survival while increasing water supply reliability.

- **Preliminary Comprehensive Plan 5 (PCP5) –** 18.5-foot dam raise, enlarging the reservoir by 634,000 acre-feet, a combination plan focusing on all objectives.

As described further in Chapter 3, "Considerations for Describing Affected Environment and Environmental Consequences," Section 3.2.3, "Methods and Assumptions," due to uncertainty related to CVP and SWP operational constraints, water operations modeling and related evaluations in the 2011 Draft Feasibility Report and Preliminary DEIS were based on available modeling analyses at the time. This modeling reflected CVP and SWP operations and constraints described in:

- The Reclamation 2004 *Long-Term CVP and SWP Operations Criteria and Plan Biological Assessment* (2004 OCAP Biological Assessment (BA)) (Reclamation 2004)

- The NMFS 2004 *Biological Opinion on the Long-Term Central Valley Project and State Water Project Operations Criteria and Plan NMFS Biological Opinion* (2004 NMFS Biological Opinion (BO)) (NMFS 2004)

- The USFWS 2005 *Reinitiation of Formal and Early Section 7 Endangered Species Consultation on the Coordinated Operations of the Central Valley Project and State Water Project and the Operational Criteria and Plan to Address Potential Critical Habitat Issues* (2005 USFWS BO) (USFWS 2005)

These analyses were suitable for comparison purposes, and reflected expected variation among the alternatives, including the type and relative magnitude of anticipated impacts and benefits.

Because of the large number of possibilities for increasing anadromous fish survival, additional analyses were conducted to determine the combination of actions that would provide the greatest overall benefits within PCP4. These analyses are described below.

Refinement of Plan for Anadromous Fish Survival Focus with Water Supply Reliability Primarily using the SALMOD model, and based on output from the water operations (CalSim-II), reservoir temperature, and river temperature models, a suite of flow- and temperature-focused actions (scenarios) were investigated to assess which combination of actions would likely result in the maximum increase in fish populations.

To formulate PCP4, three dam height raises were considered (6.5 feet, 12.5 feet, and 18.5 feet), resulting in 256,000 acre-feet, 443,000 acre-feet, and 634,000 acre-feet of increased storage, respectively. For each of these proposed dam raises, several combinations for allocating the increased storage were analyzed. For instance, assuming a dam raise of 12.5 feet, three options were considered: (1) no increase in the minimum pool, (2) an increase in the minimum pool similar to a 6.5-foot dam raise, and (3) all of the increased space dedicated to increased fisheries. The combinations considered represent scenarios developed to focus on increasing the cold-water pool, and are listed in Table 2-3.

Table 2-3. Scenarios Considered for Cold-Water Storage – Anadromous Fish Survival Focus with Water Supply Reliability

Scenario	Dam Raise (feet)	Enlarged Reservoir	Description
A (PCP1)	6.5	256,000 acre-feet	No increase in minimum pool.
B	6.5	256,000 acre-feet	Dedicate 256,000 acre-feet of water from increased storage to increase the size of the cold-water pool for fishery benefit.
C (PCP2)	12.5	443,000 acre-feet	No increase in minimum pool.
D	12.5	443,000 acre-feet	Dedicate 187,000 acre-feet of the additional water from increased storage to increase the size of the cold-water pool for fishery benefit.
E	12.5	443,000 acre-feet	Dedicate 443,000 acre-feet of water from increased storage to increase the size of the cold-water pool for fishery benefit.
F (PCP3/PCP5)	18.5	634,000 acre-feet	No increase in minimum pool.
G	18.5	634,000 acre-feet	Dedicate 191,000 acre-feet of the additional water from increased storage to increase the size of the cold-water pool for fishery benefit.
H (PCP4)	18.5	634,000 acre-feet	Dedicate 378,000 acre-feet of the additional water from increased storage to increase the size of the cold-water pool for fishery benefit.
I	18.5	634,000 acre-feet	Dedicate 634,000 acre-feet of water from increased storage to increase the size of the cold-water pool for fishery benefit.

Note:
Water operations based on the NMFS 2004 *Biological Opinion on the Long-Term Central Valley Project and State Water Project Operations Criteria and Plan NMFS Biological Opinion* (NMFS 2004); and the USFWS 2005 *Reinitiation of Formal and Early Section 7 Endangered Species Consultation on the Coordinated Operations of the Central Valley Project and State Water Project and the Operational Criteria and Plan to Address Potential Critical Habitat Issues* (USFWS 2005)
Key:
NMFS = National Marine Fisheries Services
PCP1 = Preliminary Comprehensive Plan 1
PCP2 = Preliminary Comprehensive Plan 2
PCP3 = Preliminary Comprehensive Plan 3
PCP4 = Preliminary Comprehensive Plan 4
PCP5 = Preliminary Comprehensive Plan 5
USFWS = U.S. Department of the Interior, Fish and Wildlife Service

Additional scenarios focusing on increasing Sacramento River flows with an 18.5-foot raise were also analyzed. The flow combinations were based primarily on flows identified as part of the Anadromous Fish Restoration Plan (USFWS 2001). These scenarios are listed in Table 2-4.

Table 2-4. Scenarios Considered to Augment Flows – Anadromous Fish Survival Focus Plan

Flow Augmentation Scenario	Dam Raise (feet)	Enlarged Reservoir	Description
1	18.5	634,000 acre-feet	October – March AFRP flows or 500 cfs increase, whichever is less.
2	18.5	634,000 acre-feet	October – March AFRP flows or 750 cfs increase, whichever is less.
3	18.5	634,000 acre-feet	October – March AFRP flows or 1,000 cfs increase, whichever is less.
4	18.5	634,000 acre-feet	Increase August flows to 10,000 cfs and September flows to 6,000 cfs for temperature control.

Note:
Water operations based on the NMFS 2004 *Biological Opinion on the Long-Term Central Valley Project and State Water Project Operations Criteria and Plan NMFS Biological Opinion* (NMFS 2004); and the USFWS 2005 *Reinitiation of Formal and Early Section 7 Endangered Species Consultation on the Coordinated Operations of the Central Valley Project and State Water Project and the Operational Criteria and Plan to Address Potential Critical Habitat Issues* (USFWS 2005)
Key:
AFRP = Anadromous Fish Restoration Plan (USFWS 2001)
cfs = cubic feet per second
NMFS = National Marine Fisheries Services
USFWS = U.S. Department of the Interior, Fish and Wildlife Service

Quantitative analysis indicated that increasing the minimum pool in Shasta Reservoir would have the greatest net fishery benefit. By increasing the minimum pool, the allowable carryover pool storage would increase in the reservoir. This carryover would act to conserve cold water that could be managed to better benefit anadromous fish. Scenarios 1, 2, 3, and 4 (flow augmentation scenarios) showed limited benefits to anadromous fish compared with other scenarios, and were eliminated from further analysis. Scenarios B, E, and I would not contribute to increased water supply reliability. Although PCP4 focuses on anadromous fish survival, because these three scenarios would not contribute to a primary objective, they were deleted from further consideration. Of the remaining scenarios, Scenarios D and H were deemed to be the most cost-effective. Based on further analysis, Scenario H was chosen to represent reservoir operations in PCP4 because this scenario would provide the greatest benefit to anadromous fish and still meet the primary objective of water supply reliability. Scenario comparison and selection are discussed further in the Plan Formulation Appendix.

Refinement of Comprehensive Plans for the DEIS and Final EIS

Comprehensive plans were further refined for the DEIS based on several factors, including updates to CVP and SWP water operations and stakeholder input. Since the release of the Draft Feasibility Report and Preliminary DEIS, water operations modeling in CalSim-II and related analyses were updated to include the following:

- The USFWS 2008 *Formal Endangered Species Act Consultation on the Proposed Coordinated Operations of the CVP and SWP* (2008 USFWS BO) (USFWS 2008)
- The NMFS 2009 *BO and Conference Opinion on the Long-Term Operations of the CVP and SWP* (2009 NMFS BO) (NMFS 2009)
- Additional changes in CVP and SWP facilities and operations, such as the enlarged Los Vaqueros Reservoir and implementation of the San Joaquin River Restoration Program
- Additional changes in non-CVP/SWP facilities and operations, such as the addition of the Freeport Regional Water Project

Preliminary analyses based on these updated operations indicated shifts in the distribution of water supply benefits from M&I to agricultural uses, resulting in decreased M&I water supply benefits for the Draft Feasibility Report comprehensive plans.

To improve the balance between agricultural and M&I water supply benefits, a portion of the increased storage capacity in Shasta Reservoir was reserved to specifically focus on increasing M&I deliveries during dry and critical years under Comprehensive Plan 1 (CP1), Comprehensive Plan 2 (CP2), Comprehensive Plan 4 (CP4), and Comprehensive Plan 5 (CP5). Operations targeting increased M&I deliveries were based on existing and anticipated future demands, operational priorities, and facilities of the SWP, which provides M&I water to a majority of the State’s population.

In addition, to provide a greater range of focus and operations within the set of comprehensive plans, water supply operations for Comprehensive Plan 3 (CP3) were focused on agricultural water supply reliability and anadromous fish survival. Accordingly, for CP3, none of the increased storage capacity in Shasta Reservoir was reserved for increasing M&I deliveries.

Refinement of Operational Scenario for Plan Focused on Anadromous Fish Survival with Water Supply Reliability Based on public comments on the Draft Feasibility Report and DEIS, a refined operational scenario (Comprehensive Plan 4A (CP4A)) was developed for the anadromous fish focused plan. This new operational scenario is a refinement of the operations for CP4, based on several factors, including the updated CVP and SWP operations, described above, which are based on the 2008 USFWS BO and 2009 NMFS BO. A suite of temperature and flow-focused actions (scenarios) were investigated to assess which combination of actions would likely maximize increases in anadromous fish populations. These investigations primarily used the SALMOD model, and were based on output from the water operations (CalSim-II), reservoir temperature, and river temperature models. Similar scenario refinements were considered for the Draft Feasibility Report, as summarized in Table 2-3 and Table 2-4. However, Draft Feasibility Report scenarios were based on CVP and SWP operational scenarios including the 2004 NMFS BO and 2005 USFWS BO, which have been since updated.

A range of scenarios were considered during the development of CP4A. For these scenarios, several combinations for allocating the increased storage were analyzed, focusing on either increasing the volume of the cold-water pool in Shasta Reservoir or augmenting flows downstream from Shasta Dam. Flow augmentation scenarios were based primarily on flows identified as part of the Anadromous Fish Restoration Plan (USFWS 2001). Table 2-5 highlights the range of scenarios considered and estimated benefits to water supply reliability and anadromous fisheries under each scenario.

CP4A was selected as the refined operational scenario for CP4, as it allows for improved balance between water supply benefits and fisheries benefits compared to other scenarios.

Table 2-5. Scenarios Considered for Refinement of Final EIS Comprehensive Plans

Scenario	Dam Raise (feet)	Enlarged Reservoir (acre-feet)	Description	Production Increase (number of fish)[1]	Total Increase in Water Supply Reliability[2] Average (acre-feet/year)	Total Increase in Water Supply Reliability[2] Dry/Critical (acre-feet/year)
Scenarios Considered for Cold-Water Storage as Part of Fish Focus Plan						
A (CP1)	6.5	256,000	No increase in minimum cold-water pool for fishery benefit. 70,000 acre-feet and 35,000 acre-feet of the increased storage capacity in Shasta Reservoir was reserved for increasing M&I deliveries in dry and critical years, respectively.	61,300	31,000	47,300
B	6.5	256,000	Dedicate 256,000 acre-feet of water from increased storage to increase the size of the cold-water pool for fishery benefit. No increased storage capacity in Shasta Reservoir reserved for water supply.	673,000	0	0
C (CP2)	12.5	443,000	No increase in minimum cold-water pool for fishery benefit. 100,000 acre-feet and 50,000 acre-feet of the increased storage capacity in Shasta Reservoir was reserved for increasing M&I deliveries in dry and critical years, respectively.	379,200	51,300	77,800
D	12.5	443,000	Dedicate 187,000 acre-feet of the additional water from increased storage to increase the size of the cold-water pool for fishery benefit. 70,000 acre-feet and 35,000 acre-feet of the increased storage capacity in Shasta Reservoir was reserved for increasing M&I deliveries in dry and critical years, respectively.	428,700	31,000	47,300
E	12.5	443,000	Dedicate 443,000 acre-feet of water from increased storage to increase the size of the cold-water pool for fishery benefit. No increased storage capacity in Shasta Reservoir reserved for water supply.	999,900	0	0
F (CP3)	18.5	634,000	No increase in minimum cold-water pool for fishery benefit. Increased storage capacity in Shasta Reservoir dedicated to agricultural deliveries.	207,400	61,700	63,100
F (CP5)	18.5	634,000	No increase in minimum cold-water pool for fishery benefit. 150,000 acre-feet and 75,000 acre-feet of the increased storage capacity in Shasta Reservoir was reserved for increasing M&I deliveries in dry and critical years, respectively.	377,800	75,900	113,500

Table 2-5. Scenarios Considered for Refinement of Final EIS Comprehensive Plans (contd.)

Scenario	Dam Raise (feet)	Enlarged Reservoir (acre-feet)	Description	Production Increase (number of fish)[1]	Total Increase in Water Supply Reliability[2] Average (acre-feet/year)	Total Increase in Water Supply Reliability[2] Dry/Critical (acre-feet/year)
4[4]	18.5	634,000	Increase August flows to 10,000 cfs and September flows to 6,000 cfs for temperature control. 150,000 acre-feet and 75,000 acre-feet of the increased storage capacity in Shasta Reservoir was reserved for increasing M&I deliveries in dry and critical years, respectively.	63,900	73,000	122,800
F (CP4A)	18.5	634.000	Dedicate 191,000 acre-feet of the additional water from increased storage to increase the size of the cold-water pool for fishery benefit. 100,000 acre-feet and 50,000 acre-feet of the increased storage capacity in Shasta Reservoir was reserved for increasing M&I deliveries in dry and critical years, respectively.	710,000	51,300	77,800
C (CP4)	18.5	634,000	Dedicate 378,000 acre-feet of the additional water from increased storage to increase the size of the cold-water pool for fishery benefit. 70,000 acre-feet and 35,000 acre-feet of the increased storage capacity in Shasta Reservoir was reserved for increasing M&I deliveries in dry and critical years, respectively.	812,600	31,000	47,300
I	18.5	634.000	Dedicate 634,000 acre-feet of water from increased storage to increase the size of the cold-water pool for fishery benefit. No increased storage capacity in Shasta Reservoir reserved for water supply.	971,400	0	0
Scenarios Considered to Augment Flows as Part of Fish Focus Plan						
1[3]	18.5	634,000	October - March AFRP flows or 500 cfs increase, whichever is lower. Increased storage capacity in Shasta Reservoir dedicated to agricultural deliveries.	348,700	54,600	57,200
1[4]	18.5	634,000	October - March AFRP flows or 500 cfs increase, whichever is lower. 150,000 acre-feet and 75,000 acre-feet of the increased storage capacity in Shasta Reservoir was reserved for increasing M&I deliveries in dry and critical years, respectively.	319,300	65,000	91,300
3[3]	18.5	634,000	October - March AFRP flows or 1,000 cfs increase, whichever is lower. Increased storage capacity in Shasta Reservoir dedicated to agricultural deliveries.	222,800	42,200	35,700
3[4]	18.5	634,000	October - March AFRP flows or 1,000 cfs increase, whichever is lower. 150,000 acre-feet and 75,000 acre-feet of the increased storage capacity in Shasta Reservoir was reserved for increasing M&I deliveries in dry and critical years, respectively.	309,500	54,600	69,300
4[3]	18.5	634,000	Increase August flows to 10,000 cfs and September flows to 6,000 cfs for temperature control. Increased storage capacity in Shasta Reservoir dedicated to agricultural deliveries.	88,400	62,600	76,400

Table 2-5. Scenarios Considered for Refinement of Final EIS Comprehensive Plans (contd.)

Scenario	Dam Raise (feet)	Enlarged Reservoir (acre-feet)	Description	Production Increase (number of fish)[1]	Total Increase in Water Supply Reliability[2] Average (acre-feet/year)	Total Increase in Water Supply Reliability[2] Dry/Critical (acre-feet/year)
4[4]	18.5	634,000	Increase August flows to 10,000 cfs and September flows to 6,000 cfs for temperature control. 150,000 acre-feet and 75,000 acre-feet of the increased storage capacity in Shasta Reservoir was reserved for increasing M&I deliveries in dry and critical years, respectively.	63,900	73,000	122,800

Note:

[1] Estimates of increased anadromous fish survival were based on simulations using the SALMOD model. These estimates represent an index of production increase, based on the simulated average annual increase in juvenile Chinook salmon surviving to migrate downstream from the Red Bluff Pumping Plant.

[2] Increased water supply reliability was simulated with CalSim-II based on October to September water years. Water Year Types Based on the Sacramento Valley Water Year Hydrologic Classification. Water operations based on the USFWS 2008 *USFWS 2008 Formal Endangered Species Act Consultation on the Proposed Coordinated Operations of the CVP and SWP (*USFWS 2008) and NMFS 2009 *Biological Opinion and Conference Opinion on the Long-Term Operations of the CVP and SWP* (NMFS 2009).

[3] Refined operational scenario based on CP3 and corresponding distribution of water supply benefits.

[4] Refined operational scenario based on CP5 and corresponding distribution of water supply benefits.

Key:
AFRP = Anadromous Fish Restoration Program
cfs = cubic feet per second
CP = Comprehensive Plan
CVP = Central Valley Project
EIS = Environmental Impact Statement
M&I = municipal and industrial
NMFS = National Marine Fisheries Service
SWP = State Water Project
USFWS = U.S. Department of the Interior, Fish and Wildlife Service

Based on the refinements described above, this EIS includes the following comprehensive plans:

- **CP1 –** 6.5-foot dam raise, enlarging the reservoir by 256,000 acre-feet, focusing on both anadromous fish survival and water supply reliability.
- **CP2 –** 12.5-foot dam raise, enlarging the reservoir by 443,000 acre-feet, focusing on both anadromous fish survival and water supply reliability.
- **CP3 –** 18.5-foot dam raise, enlarging the reservoir by 634,000 acre-feet, focusing on both agricultural water supply reliability and anadromous fish survival.
- **CP4 and CP4A –** 18.5-foot dam raise, enlarging the reservoir by 634,000 acre-feet, focusing on anadromous fish survival while increasing water supply reliability.
- **CP5 –** 18.5-foot dam raise, enlarging the reservoir by 634,000 acre-feet, a combination plan focusing on all objectives.

Comprehensive plans for this EIS are described in detail in Section 2.3, "Action Alternatives," below.

2.2 No-Action Alternative

NEPA and CEQA require the analysis of a baseline alternative, representing a scenario in which the project is not implemented. For all Federal feasibility studies of potential water resources projects, the NEPA No-Action Alternative is intended to account for existing facilities, conditions, land uses, and reasonably foreseeable actions expected to occur in the study area. Reasonably foreseeable actions include actions with current authorization, secured funding for design and construction, and environmental permitting and compliance activities that are substantially complete.

Under CEQA, the No-Project Alternative is similar to NEPA's No-Action Alternative, but it involves the review of two scenarios: the existing condition baseline, which represents only current conditions at the time the Notice of Preparation is published, and "reasonably foreseeable" future conditions without the project (which is equivalent to the NEPA No-Action Alternative).

For the SLWRI, the No-Action Alternative (which also constitutes the No-Project Alternative under CEQA, as previously mentioned) is based on CVP and SWP operational conditions described in the 2008 *Biological Assessment on the Continued Long-Term Operations of the CVP and SWP* (2008 Long-Term Operation BA), and the BOs issued by USFWS and NMFS in 2008 and 2009, respectively. The No-Action Alternative also includes continued implementation of actions identified under the CVPIA. In addition, the No-Action Alternative includes key projects assumed to be in place and operating in the future, including the Freeport Regional Water Project, Delta Water Supply Project, South Bay Aqueduct Improvement and Enlargement Project, a functional equivalent of the Vernalis Adaptive Management Plan, full restoration flows under the San Joaquin River Restoration Program, and full implementation of the Grassland Bypass Project. The existing and future conditions for the SLWRI are further described in Chapter 3, "Considerations for Describing Affected Environment and Environmental Consequences," Section 3.2.3, "Methods and Assumptions." In addition, Table 2-1 of the Modeling Appendix shows which actions were assumed to be part of the existing condition and the future condition (or No-Action /No-Project Alternative) in the SLWRI 2012 CalSim-II model.

For this EIS, the No-Action Alternative is considered to be the basis for comparison with potential action alternatives, consistent with NEPA and P&G guidelines. Thus, if no proposed action is determined to be feasible, the No-Action Alternative is the default option.

Under the No-Action Alternative, the Federal government would continue to implement reasonably foreseeable actions, as defined above, but would not take additional actions toward implementing a plan to raise Shasta Dam to help increase anadromous fish survival in the upper Sacramento River, nor help address the growing water supply and reliability issues in California. The following discussions highlight the consequences of implementing the No-Action Alternative, as they relate to the project objectives.

In addition to comparing the No-Action Alternative to potential action alternatives, the potential action alternatives were also compared to the existing condition baseline (as described above) in consideration of CEQA requirements.

2.2.1 Anadromous Fish Survival

Much has been done to address anadromous fish survival problems in the upper Sacramento River. Solutions have ranged from changes in the timing and magnitude of releases from Shasta Dam to constructing and operating the temperature control device (TCD) at the dam. Actions also include site-specific projects, such as introducing spawning gravel to the Sacramento River, and work to improve or restore spawning habitat in tributary streams. However, to increase anadromous fish survival and reduce the risk of extinction, further water temperature improvements are needed in the Sacramento River, especially in dry and critical years. Increased demand for water for agricultural, M&I, and environmental uses is also expected to reduce the reliability of cold water for anadromous fish. Prolonged drought that depletes the cold-water pool in Shasta Reservoir could put populations of anadromous fish at risk of severe population decline or extinction in the long-term (NMFS 2014). The risk associated with a prolonged drought is especially high in the Sacramento River because Shasta Reservoir is operated to maintain only 1 year of carryover storage.

Under the No-Action Alternative, it is assumed that actions to protect fisheries and benefit aquatic environments would continue, including maintaining the TCD, ongoing spawning gravel augmentation programs, and satisfying other existing regulatory requirements.

2.2.2 Water Supply Reliability

Demands for water in the Central Valley and throughout California exceed available supplies, and the need for additional supplies is expected to grow. There is growing competition for limited system resources among various users and uses, including agricultural, M&I, and environmental. M&I water demands and environmental water requirements have each increased, resulting in greater competition for limited water supplies. As mentioned, the population of California is expected to increase by more than 60 percent above 2005 levels by 2050. Significant increases in population also are expected to occur in the Central Valley, nearly 130 percent above 2005 levels by 2050 (California Department of Finance 2007). As these population increases occur, and are coupled with the need to maintain a healthy and vibrant industrial and agricultural economy, the demand for water would continue to significantly exceed available supplies. Competition for available water supplies would intensify as water demands increase to support this population growth.

Water conservation and reuse efforts are expected to substantially increase, and forced conservation resulting from increasing water shortages would continue. Without developing cost-effective new sources, however, the growing urban population would increasingly rely on shifting water supplies from such areas as agricultural production to satisfy M&I demands. In the urban sector, reduced supplies or increased supply uncertainty could cause water rates to increase as agencies seek to remedy supply shortfalls by implementing measures to reduce demand and/or augment supplies.

It is likely that with continued and deepening shortages in available water supplies, adverse economic and socioeconomic impacts would increase over time in the Central Valley and elsewhere in California. One example could include higher water costs, resulting in a further shift in agricultural production to areas outside California and/or outside the United States. Another example could include water supply shortages resulting in changes in land use patterns, loss and destruction of permanent crops, and/or decreased production of existing crops. In response to reduced water supplies, farmers may fallow fields, reducing agricultural productivity directly, resulting in layoffs, reduced hours for agricultural employees, and increased unemployment in agricultural communities. Reduced water supplies and the resulting employment losses could also cause socioeconomic impacts in affected communities.

Under the No-Action Alternative, Shasta Dam would not be modified and the CVP would continue operating similarly to existing conditions. The No-Action Alternative would continue to meet water supply demands at levels similar to existing conditions, but would not be able to meet the expected increased demand in California.

2.2.3 Ecosystem Resources, Flood Management, Hydropower Generation, Recreation, and Water Quality

As opportunities arise, some efforts would likely continue to improve environmental conditions on tributaries to Shasta Lake and along the upper Sacramento River. However, overall, future environmental conditions in these areas would likely be similar to existing conditions. The quantity, quality, diversity, and connectivity of riparian, wetland, and riverine habitats along the Sacramento River have been limited by confinement of the river system by levees, reclamation of adjacent lands for farming, bank protection, channel stabilization, and land development.

Shasta Dam and Reservoir have greatly reduced flood damage along the Sacramento River. Shasta Dam and Reservoir were constructed at a total cost of about $36 million in 1936 (about $2 billion in 2014 dollars). Shasta Dam, in combination with the Sacramento River Flood Control Project, protects about 1 million people and over $60 billion in assets. However, residual risks to human life, health, and safety along the Sacramento River remain. Development in flood-prone areas has exposed the public to the risk of flooding. Storms producing peak flows, and volumes greater than the existing flood management system was designed for, can occur, and result in extensive flooding along the upper Sacramento River. Under the No-Action Alternative, the threat of flooding would continue, and may increase as population growth continues.

California's demand for electricity is expected to substantially increase in the future. Under the No-Action Alternative, no actions would be taken to help meet this growing demand.

As California's population continues to grow, demands would grow substantially for water-oriented recreation at and near the lakes, reservoirs, streams, and rivers of the Central Valley. This increase in demand would be especially pronounced at Shasta Lake.

To address the impact of water quality deterioration on the Sacramento River basin and Delta ecosystems and endangered and threatened fish populations, several environmental flow goals and objectives in the Central Valley (including the Delta) have been established through legal mandates aimed at maintaining and recovering endangered and threatened fish and wildlife, and protecting designated critical habitat. Despite these efforts, under the No-Action Alternative, these resources would continue to decline and ecosystems would continue to be impacted. In addition, Delta water quality may continue to decline.

2.3 Action Alternatives

The comprehensive plans designated as the action alternatives for the purpose of this EIS include:

- **CP1 –** 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability
- **CP2 –** 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability
- **CP3 –** 18.5-Foot Dam Raise, Agricultural Water Supply Reliability and Anadromous Fish Survival
- **CP4 and CP4A –** 18.5-Foot Dam Raise, Anadromous Fish Focus with Water Supply Reliability
- **CP5 –** 18.5-Foot Dam Raise, Combination Plan

Management measures and environmental commitments common to all action alternatives are described first, in Sections 2.3.1, "Management Measures Common to All Action Alternatives," and 2.3.2, "Environmental Commitments Common to All Action Alternatives." Then, major components, potential benefits, and operations and maintenance for each action alternative are described in Sections 2.3.3, "CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability," through 2.3.7, "CP5 – 18.5-Foot Dam Raise, Combination Plan." Physical features and related construction activities for each action alternative are described in Section 2.3.8, "Comprehensive Plan Construction Activities." Detailed discussions of potential effects and proposed mitigation measures for each action alternative are included in Chapters 4 through 25 of the EIS. A compilation of all mitigation measures for all action alternatives is included in the Preliminary Environmental Commitments and Mitigation Plan Appendix. If any action alternative was authorized by Congress, Reclamation would implement the components of the plans, environmental commitments, mitigation measures, and permit and approval conditions, as described throughout this EIS and in any required permits or approvals issued for implementation.

The environmental commitment section of the DEIS included a commitment to develop and implement a mitigation plan to minimize potential impacts to physical, biological, and socioeconomic resources. In conjunction with an interagency, interdisciplinary team, Reclamation refined and enhanced the mitigation measures, including developing a framework to quantify impacts (where appropriate) and establish mitigation ratios that were applicable to a number of impacts related to biological resources. For this Final EIS, the refined and enhanced mitigation measures have been incorporated into Chapters 4 through 25 and are presented in the Preliminary Environmental Commitments and Mitigation Plan Appendix.

2.3.1 Management Measures Common to All Action Alternatives

Eight of the management measures retained during the alternatives development process are included, to some degree, in all of the action alternatives. These measures were included because they (1) would either be incorporated or required with any dam raise, (2) were logical and convenient additions that would significantly improve any alternative, or (3) should be considered with any new water increment developed in California. The eight measures include enlarging the Shasta Lake cold-water pool, modifying the TCD, increasing conservation storage, reducing demand, modifying flood operations, modifying hydropower facilities, maintaining or increasing recreation opportunities, and maintaining or improving water quality.

Enlarge Shasta Lake Cold-Water Pool

Cold water released from Shasta Dam significantly influences water temperature conditions in the Sacramento River between Keswick Dam and the RBPP. At a minimum, all comprehensive plans would include enlarging the cold-water pool by raising Shasta Dam to enlarge Shasta Reservoir. Some alternatives would also increase the seasonal carryover storage in Shasta Lake.

Modify Temperature Control Device

For all action alternatives, the TCD would be modified to account for an increased dam height and to reduce leakage of warm water into the structure. Minimum modifications to the TCD include raising the existing structure and modifying the shutter control. This measure would increase the ability of operators at Shasta Dam to meet downstream temperature requirements, and provide more operational flexibility to achieve desirable water temperatures during critical periods for anadromous fish.

Increase Conservation Storage

All action alternatives would include increasing the amount of space available for water conservation storage in Shasta Reservoir by raising Shasta Dam. Conservation storage is the portion of the reservoir capacity available to store water for subsequent release to increase water supply reliability for agricultural, M&I, and environmental purposes. All action alternatives would include a range of dam enlargements and increases in conservation space.

Reduce Demand

All action alternatives would include a water conservation program for increased water deliveries that would be created by the project to augment current water use efficiency practices. The proposed program would consist of a 10-year initial program to which Reclamation would allocate approximately $1.6 million to $3.8 million to fund water conservation efforts. Funding would be proportional to additional water supplies delivered and would focus on assisting project beneficiaries (agencies receiving increased water supplies because of the project), with developing new or expanded urban water conservation, agricultural water conservation, and water recycling programs. Program actions would be a combination of technical assistance, grants, and loans to support a variety of water conservation projects, such as recycled wastewater projects, irrigation system retrofits, and urban utilities retrofit and replacement programs. Reclamation, in collaboration with project beneficiaries, would identify and develop water conservation projects for funding under the program. Reclamation would then implement an investment strategy, in coordination with project beneficiaries, to identify and prioritize projects which, in conjunction with other water conservation activities, would cost-effectively reduce water demand and increase water conservation. This process would result in developing, evaluating, and prioritizing projects for funding. The program could be established as an extension of existing Reclamation programs, or as a new program through teaming with cost-sharing partners. Combinations and types of water use efficiency actions funded would be tailored to meet the needs of identified cost-sharing partners, including consideration of cost-effectiveness at a regional scale for agencies receiving funding.

Modify Flood Operations

Potential modification of flood operations would be considered for all action alternatives. Enlargement of Shasta Reservoir would require alterations to existing flood operation guidelines or rule curves, to reflect physical modifications, such as an increase in dam/spillway elevation. The rule curves would be revised with the goal of reducing flood damage and enhancing other objectives to the extent possible.

Modify Hydropower Facilities

Under each action alternative, enlargement of Shasta Dam would likely require various minimum modifications, commensurate with the magnitude of the enlargement, to the existing hydropower facilities at the dam to enable their continued efficient use. These modifications, in conjunction with increased lake surface elevations, may provide incidental benefits to hydropower generation. Although modifications could also be included to further increase the power production capabilities of the reservoir (e.g., additional penstocks and generators), they are believed to be a detail beyond the scope of this investigation and are not considered further at this level of planning.

Maintain and Increase Recreation Opportunities

In addition to the measures described above, all action alternatives would address, to some extent, the secondary objective of maintaining or increasing recreation opportunities at Shasta Lake. Outdoor recreation, and especially recreation at Shasta Lake, represents a major source of enjoyment to millions of people annually and is a major source of income to the northern Sacramento Valley. Shasta Dam and Reservoir are within the Shasta Unit of the Whiskeytown-Shasta-Trinity National Recreation Area (NRA). Recreation within these lands is managed by USFS. As part of this administration, USFS either directly operates and maintains, or manages through special use permits, numerous public campgrounds, marinas, boat launching facilities, and related water-oriented recreation facilities. Enlarging Shasta Dam and Reservoir would affect some of these facilities. Consistent with the position of USFS, and planning conditions described in this chapter, all of the action alternatives would include features to, at a minimum, maintain the overall recreation capacity of the existing facilities. All action alternatives would also provide for modernization of relocated recreation facilities, including, at a minimum, modifications to comply with current standards of health and safety.

Maintain or Improve Water Quality

All action alternatives could contribute to improved Delta water quality conditions and Delta emergency response. Additional storage in Shasta Reservoir would provide improved operational flexibility. Shasta Dam has the ability to provide increased releases and high-flow releases to improve Delta water quality. Improved Delta water quality conditions could provide benefits for both water supply reliability and ecosystem restoration by potentially increasing Delta outflow during drought years and reducing salinity during critical periods.

2.3.2 Environmental Commitments Common to All Action Alternatives

Reclamation and/or its contractors would incorporate certain environmental commitments and best management practices (BMP) into any action alternative identified for implementation to avoid or minimize potential impacts. Reclamation would also coordinate planning, engineering, design and construction, operation, and maintenance phases of any authorized project modifications with applicable resource agencies.

The following environmental commitments would be incorporated into any action alternative for any project-related construction activities. This section does not include mitigation measures.

Develop and Implement Construction Management Plan

Reclamation would develop and implement a construction management plan to avoid or minimize potential impacts on public health and safety during project construction, to the extent feasible. The construction management plan would inform contractors and subcontractors of work hours, modes and locations of transportation, and parking for construction workers; location of overhead and underground utilities; worker health and safety requirements; truck routes; stockpiling and staging procedures; public access routes; terms and conditions of all required project permits and approvals; and emergency response services contact information.

The construction management plan would also include construction notification procedures for the police, public works, and fire departments in the area where construction would occur. In addition, the construction management plan would include similar procedures for Federal and State agencies with similar jurisdictions, including USFS. Notices would also be distributed to neighboring property owners. The health and safety component of the construction management plan would be monitored for the implementation of the plan on a day-to-day basis by a Certified Industrial Hygienist.

The construction management plan would include effort to notify businesses, residents, and visitors associated with recreation activities on and surrounding Shasta Lake. In addition to information available at the Shasta Lake Visitors Center, informational signs and booths would be placed at key locations to be identified by Reclamation in conjunction with agencies and local business organizations. Reclamation will also develop and maintain a project-specific website that will be used for a wide range of informational purposes.

Comply with Permit Terms and Conditions

If any action alternative is approved and authorized for construction, Reclamation would require its contractors and suppliers, its general contractor, and all of the general contractor's subcontractors and suppliers to comply with all of the terms and conditions of all required project permits, approvals, and conditions attached thereto. If necessary, additional information (e.g., detailed designs and additional documentation) would be prepared and provided for review by decision makers and the public. Reclamation would ultimately be responsible for the actions of its contractors in complying with permit conditions. Compliance with applicable laws, policies, and plans for this project is discussed in Chapter 26, "Other Required Disclosures ," Section 26.7, "Compliance with Applicable Laws, Policies, and Plans," of this EIS.

Provide Relocation Assistance Through Federal Relocation Assistance Program

All Federal, State, and local government agencies and others receiving Federal financial assistance for public programs and projects that require the acquisition of real property must comply with the policies and provisions set forth in the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended (Uniform Act) (Title 49, CFR, Part 24). All relocation and property acquisition activities would be performed in compliance with the Uniform Act. Any individual, family, or business displaced by implementation of any of the action alternatives would be offered relocation assistance services for the purpose of locating a suitable replacement property, to the extent consistent with the Uniform Act.

Under the Uniform Act, relocation services for residences would include providing a determination of the housing needs and desires, a list of comparable properties, transportation to inspect housing referrals, and reimbursement of moving costs and related expenses. For business relocation activities, relocation services would include providing a determination of the relocation needs and requirements; a determination of the need for outside specialists to plan, move, and reinstall personal property; advice as to possible sources of funding and assistance from other local, State, and Federal agencies; listings of commercial properties; and reimbursement for costs incurred in relocating and reestablishing the business. No relocation payment received would be considered as income for the purpose of the Internal Revenue Code.

Remain Consistent with USFS Built Environment Image Guide

Any facilities subject to USFS authorization that are constructed or reconstructed would be consistent with USFS Built Environment Image Guide. The architectural character of facilities on National Forest System lands would be constructed using materials and design that keep with the visual and cultural identity of the landscape in which they are constructed. Reclamation would seek to maintain the quality of visitor experiences by replacing affected facilities with facilities providing equivalent visual resource quality and amenities.

Protect Public Land Survey System Monuments and Property Corners

Reclamation would identify Public Land Survey System (PLSS) monuments or survey property corners affected by either inundation due to increased lake levels or construction activities. Reclamation or its contractors would protect all PLSS monuments and associated references and all property corners, either by positioning, or, where necessary, creating new references. The results would be filed with BLM and Shasta County.

Evaluate and Protect Paleontological Resources Discovered During Construction

If paleontological resources are discovered during construction activities, all work in the immediate vicinity of the discovery would stop immediately and Reclamation would be notified (as applicable). A qualified paleontologist would be retained to evaluate the find and recommend appropriate conservation measures, such as data recovery or protection in place. The conservation measures would be implemented before reinitiation of activities in the immediate vicinity of the discovery.

Develop and Implement Stormwater Pollution Prevention Plan

Any project authorized for construction would be subject to the construction-related stormwater permit requirements of the CWA National Pollutant Discharge Elimination System program. Reclamation would obtain any required permits through the Central Valley Regional Water Quality Control Board before any ground-disturbing construction activity. According to the requirements of Section 402 of the CWA, Reclamation and/or its contractors would prepare and implement a Stormwater Pollution Prevention Plan (SWPPP) before construction, identifying BMPs to prevent or minimize erosion and the discharge of sediments and other contaminants with the potential to affect beneficial uses of or lead to violations of water quality objectives for surface waters. The SWPPP would include site-specific structural and operational BMPs to prevent and control impacts on runoff quality, and procedures to be followed before each storm event. BMPs would control short-term and long-term erosion and sedimentation effects and stabilize soils and vegetation in areas affected by construction activities. The SWPPP would contain a site map that shows the construction site perimeter, existing and proposed buildings, lots, roadways, stormwater collection and discharge points, drainage patterns across the project, and general topography both before and after construction. Additionally, the SWPPP would contain a visual monitoring program, a chemical monitoring program for “non-visible” pollutants that would be implemented if a BMP fails, and a sediment monitoring plan to be implemented if a particular site discharges directly to a water body listed on the CWA 303(d) list for sediment. BMPs for the project could include, but would not be limited to, silt fencing, straw bale barriers, fiber rolls, storm drain inlet protection, hydraulic mulch, and stabilized construction entrances.

Develop and Implement Erosion and Sediment Control Plan Reclamation would prepare and implement an erosion and sediment control plan to control short-term and long-term erosion and sedimentation effects, and to stabilize soils and vegetation in areas affected by construction activities. The plan would include all of the necessary local jurisdiction requirements regarding erosion control, and would implement BMPs for erosion and sediment control, as required. Types of BMPs may include, but would not be limited to, earth dikes and drainage swales, stream bank stabilization, and use of silt fencing, sediment basins, fiber rolls, and sandbag barriers.

Develop and Implement Feasible Spill Prevention and Hazardous Materials Management As part of the SWPPP, Reclamation and/or its contractors would develop and implement a spill prevention and control plan to minimize effects from spills of hazardous, toxic, or petroleum substances for project-related construction activities occurring in or near waterways. The accidental release of chemicals, fuels, lubricants, and nonstorm drainage water into water bodies would be prevented to the extent feasible. Spill prevention kits would always be close by when hazardous materials would be used (e.g., crew trucks and other logical locations). Feasible efforts would be implemented so that hazardous materials would be properly handled and the quality of aquatic resources would be protected by all reasonable means during work in or near any waterway. No fueling would be done within the ordinary high-water mark, immediate floodplain, or full pool inundation area, unless equipment stationed in these locations could not be readily relocated. Any equipment that could be readily moved out of the water body would not be fueled in the water body or immediate floodplain. For all fueling of stationary equipment done at the construction site, containments would be installed so that any spill would not enter the water, contaminate sediments that may come in contact with the water, or damage wetland or riparian vegetation. Any equipment that could be readily moved out of the water body would not be serviced within the ordinary high-water mark or immediate floodplain.

Additional BMPs designed to avoid spills from construction equipment and subsequent contamination of waterways would also be implemented. These could include, but would not be limited to, the following:

- Storage of hazardous materials in double-containment and, if possible, under a roof or other enclosure.
- Disposal of all hazardous and nonhazardous products in a proper manner.
- Monitoring of on-site vehicles for fluid leaks and regular maintenance to reduce the chance of leakage.
- Containment (using a prefabricated temporary containment mat, a temporary earthen berm, or other feature can provide containment) of bulk storage tanks.

Haulers delivering materials to the project site would be required to comply with regulations on the transport of hazardous materials codified in Title 49, CFR Part 173; Title 49, CFR Part 177; and Title 26, California Code of Regulations (CCR) Division 6. These regulations provide specific packaging requirements, define unacceptable hazardous materials shipments, and prescribe safe-transit practices, including route restrictions, by carriers of hazardous materials.

Water Quality Protection for In-River Construction

The efforts discussed below would be implemented to minimize potential adverse effects to water quality.

Implement In-River Construction Work Windows All construction activities along the Sacramento River would be conducted during months when instream flows were managed outside the flood season (e.g., June to September). In-river work between Keswick Dam and the RBPP would be conducted to minimize impacts to Sacramento River winter-run Chinook salmon (i.e., mid-August through September).

Comply with All Water Quality Permits and Regulations Project activities would be conducted to comply with all additional requirements specified in required permits relating to water quality protection. Relevant permits anticipated to be obtained for the proposed action include a CWA Section 401 certification and CWA Section 404 compliance through the USACE.

Implement Water Quality Best Management Practices BMPs that would be implemented to avoid and/or minimize potential impacts associated with construction and the 10-year-long spawning gravel augmentation program are described below.

Handle Spawning Gravel to Minimize Potential Water Quality Impacts Gravel would be sorted and transported in a manner that minimizes potential water quality impacts (e.g., management of fine sediments). Gravel would be washed at least once and have a cleanliness value of 85 or higher based on California

Department of Transportation (Caltrans) Test No. 227. Gravel would also be completely free of oils, clay, debris, and organic material.

Minimize Potential Impacts Associated with Equipment Contaminants For in-river work, all equipment would be steam-cleaned every day to remove hazardous materials before the equipment entered the water. Biodegradable hydrocarbon products would be used in the heavy equipment in the stream channel.

Implement Feasible Spill Prevention and Hazardous Materials Management The accidental release of chemicals, fuels, lubricants, and non-storm drainage water into channels would be prevented to the extent feasible. Spill prevention kits would always be in close proximity when using hazardous materials (e.g., crew trucks and other logical locations). Feasible efforts would be implemented to ensure that hazardous materials are properly handled and the quality of aquatic resources is protected by all reasonable means. No fueling would be done within the ordinary high-water mark or immediate floodplain, unless equipment stationed in these locations was not readily relocated (i.e., pumps, generators). For stationary equipment that must be fueled on site, containments would be provided in such a manner that any accidental spill of fuel would not be able to enter the water or contaminate sediments that could come in contact with water. Any equipment that was readily moved out of the channel would not be fueled in the channel or immediate floodplain. All fueling done at the construction site would provide containment to the degree that any spill would be unable to enter the channel or damage wetland or riparian vegetation. No equipment servicing would be done within the ordinary high-water mark or immediate floodplain, unless equipment stationed in these locations could not be readily relocated (i.e., pumps, generators). Additional BMPs designed to avoid spills from construction equipment and subsequent contamination of waterways would also be implemented.

Minimize Potential Impacts Associated with Access and Staging Existing access roads would be used to the extent possible. Equipment staging areas would be located outside of the Sacramento River ordinary high water mark or the Shasta Dam full pool inundation area, and away from sensitive resources.

Remove Temporary Fills as Appropriate Temporary fill for access, side channel diversions, and/or side channel cofferdams, would be completely removed after completion of construction.

Remove Equipment from River Overnight and During High Flows Construction contractors would remove all equipment from the river on a daily basis at the end of the workday. Construction contractors would also monitor Reclamation’s Central Valley Operations Office Web site daily for forecasted flows posted there to determine and anticipate any potential changes in releases. If flows were anticipated to inundate a work area that would normally be dry, the contractor would immediately remove all equipment from the work area.

Extend and Enhance Existing Fish Habitat Structures in Shasta Lake

Reclamation and USFS, in conjunction with resource management agencies, would identify areas at appropriate elevations to replace, extend, and enhance existing structural fish habitat. The structures would be installed concurrently with construction activities in the vicinity of construction sites or at locations identified by resource agencies. These activities would include maintaining shallow water and transitional riverine habitat with the placement of manzanita brush structures, large woody debris, and rock-boulder clusters. To the extent feasible, vegetation cleared for construction and borrow pit areas would be used to extend and enhance fish habitat structures. Excess vegetative materials cleared from construction and borrow pit areas would be stockpiled for future fish habitat enhancement. Additionally, areas within the enlarged reservoir having appropriate conditions to establish living plants, including willow (*Salix* sp.), buttonbush (*Cephalanthus* sp.), and cottonwood (*Populus* sp.), would be identified for the purposes of providing structural fish habitat when the established plants are inundated.

Fisheries Conservation

The efforts discussed below would be implemented to minimize potential adverse effects on fish species.

Implement In-Water Construction Work Windows Reclamation would identify and implement feasible in-water construction work windows in consultation with NMFS, USFWS, and CDFW. In-water work windows would be timed to occur when sensitive fish species were not present or would be least susceptible to disturbance.

Monitor Construction Activities A qualified biologist would monitor potential impacts to important fishery resources throughout all phases of project construction. Monitoring may not be necessary during the entire duration of the project if, based on the monitor’s professional judgment (and with concurrence from Reclamation), a designated on-site contractor would suffice to monitor such activities and would agree to notify a biologist if aquatic organisms are in danger of harm. However, the qualified biologist would need to be available by phone and Internet and be able to respond promptly to any problems that arose.

Perform Fish Rescue/Salvage If spawning activities for sensitive fish species were encountered during construction activities, the biologist would be authorized to stop construction activities until appropriate corrective activities were completed or it was determined that the fish would not be harmed.

A qualified biologist would identify any fish species that may be affected by the project. The biologist would facilitate rescue and salvage of fish and other aquatic organisms that become entrapped within construction structures and cofferdam enclosures in the construction area. Any rescue, salvage, and handling of listed species would be conducted under appropriate authorization (i.e., incidental take statement/permit for the project, Federal Endangered

Species Act Section 4(d) scientific collection take permit, or a Memorandum of Understanding).

If fish were identified as threatened with entrapment in construction structures, construction would be stopped and efforts made to allow fish to leave the project area before resuming work. If fish were unable to leave the project area of their own volition, then fish would be collected and released outside the work area. Fish entrapped in cofferdam enclosures would be rescued and salvaged before the cofferdam area was completely dewatered. Appropriately sized fish screens would be installed on the suction side of any pumps used to dewater in-water enclosures.

Reporting A qualified biologist would prepare a letter report detailing the methodologies used and the findings of fish monitoring and rescue efforts. Monitoring logs would be maintained and provided, with monitoring reports. The reports would contain, but not be limited to, the following: summary of activities; methodology for fish capture and release; table with dates, numbers, and species captured and released; photographs of the enclosure structure and project site conditions affecting fish; and recommendations for limiting impacts during subsequent construction phases, if appropriate.

Survey and Monitor Fish Migration between Shasta Lake and Squaw Creek

Reclamation would fund and implement an adaptive management effort to survey and monitor fish migration between Shasta Lake and Squaw Creek, within and immediately upstream from the new inundation zone, before and immediately after project completion, to determine if warm-water fish (bass) actively migrated into and cause adverse effects on native fish, amphibians, and mollusks. These study and monitoring activities would be warranted due to uncertainties associated with the potential for warm-water fish accessing tributary stream reaches currently isolated by passage barriers near the head of the existing reservoir. The surveys would document occurrences and abundances of warm-water fish species and USFS special-status species in lower Squaw Creek before and immediately after project completion to evaluate if reservoir enlargement coincides with increases in warm-water predator species and declines of special-status indicator species. If warm-water fish abundance increases or adverse effects attributed to warm-water fish predation on native fish, amphibians or mollusks is documented within 3-5 years after the project was completed, a fish barrier or other acceptable feature would be implemented to prevent or minimize further invasions and colonization by warm-water fish.

Revegetation Plan

Reclamation, in conjunction with cooperating agencies and private landowners, would prepare a comprehensive revegetation plan to be implemented in conjunction with other management plans (e.g., SWPPP). This plan would apply to any area included as part of an action alternative, such as inundation, relocation, or mitigation activities. Overall objectives of the revegetation plan would be to reestablish native vegetation to control erosion, provide effective ground cover, minimize opportunities for nonnative plant species to establish or expand, and provide habitat diversity over time. Reclamation would work closely with cooperating agencies, private landowners, and revegetation specialists to develop the sources of native vegetation, site-specific planting patterns and species assemblages necessary for a revegetation effort of this magnitude.

Invasive Species Management

Reclamation would develop and implement a control plan to prevent the introduction of zebra/quagga mussels, invasive plants, and other invasive species to project areas. The control plan would cover all workers, vehicles, watercraft, and equipment (both land and aquatic) that would come into contact with Shasta Reservoir, the shoreline of Shasta Reservoir, the Sacramento River, and any riverbanks, floodplains, or riparian areas. Plan activities could include, but would not be limited to, the following:

- Preinspection and cleaning of all construction vehicles, watercraft, and equipment before being shipped to project areas
- Reinspection of all construction vehicles, watercraft, and equipment on arrival at project areas
- Inspection and cleaning of all personnel before work in project areas

All inspections would be conducted by trained personnel and would include both visual and hands-on inspection methods of all vehicle and equipment surfaces, up to and including internal surfaces that have contacted raw water.

Approved cleaning methods would include a combination of the following:

- **Precleaning –** Draining, brushing, vacuuming, high-pressure water treatment, thermal treatment
- **Cleaning –** Freezing, desiccation, thermal treatment, high-pressure water treatment, chemical treatment

On-site cleanings would require capture, treatment, and/or disposal of any and all water needed to conduct cleaning activities.

Fire Protection and Prevention Plan

Reclamation would prepare and implement a fire protection and prevention plan to minimize the risk of wildfire or threat to workers, property, and the public. The USFS will maintain a plan similar to this Fire Protection and Prevention Plan which addresses preventing and controlling wildfires in the NRA as described by the interagency agreement with the California Department of

Forestry and Fire Protection (Cal Fire) and other associated entities. Reclamation's contractors would follow relevant safety standards/procedures related to fire prevention, which would be incorporated into the project design and used during construction activities and project operation and maintenance. Safety standards and procedures include the California Building Code; the Shasta County Fire Plan; USFS safety requirements regarding fire hazards; Cal Fire requirements for private lands; California Public Utilities Code General Order 95, which provides procedures for proper removal, disposal, and placement of poles, wires, and associated infrastructure; and the National Electric Safety Code (a voluntary code that provides safety procedures for electric utility installation and operation). Precautionary activities to prevent construction-related fires would include locating utilities a safe distance from vegetation and structures, proper construction of power lines, and construction worker safety training. Postconstruction infrastructure operation and maintenance would follow current safety practices associated with fire prevention and would include clearing vegetation from power utility facilities and other sources using combustion engines (e.g., water pumps) on a regular basis.

Construction Material Disposal

Reclamation's contractors would recycle or reuse demolished materials, such as steel or copper wire, concrete, asphalt, and reinforcing steel, as required and where practical. Other demolished materials would be disposed of in local or other identified permitted landfills in compliance with applicable requirements.

To reduce the risk to construction workers, the public, and the environment associated with exposure to hazardous materials and waste, Reclamation would implement the following:

- A Hazardous Materials Business Plan (HMBP) would be developed and implemented to provide information regarding hazardous materials to be used for project implementation and hazardous waste that would be generated. The HMBP would also define employee training, use of protective equipment, and other procedures that provide an adequate basis for proper handling of hazardous materials to limit the potential for accidental releases of and exposure to hazardous materials. All procedures for handling hazardous materials would comply with all Federal, State, and local regulations.

- Soil to be disposed of at a landfill or recycling facility would be transported by a licensed waste hauler.

- All relevant available asbestos survey and abatement reports and supplemental asbestos surveys would be reviewed. Removal and disposal of asbestos-containing materials would be performed in accordance with applicable Federal, State, and local regulations.

- A lead-based paint survey would be conducted to determine areas where lead-based paint is present and the possible need for abatement before construction.

Asphalt Removal

Per California Fish and Game Code 5650 Section (a), all asphaltic roadways and parking lots inundated by project implementation would be demolished and removed according to Shasta County standards. Asphalt would be disposed of at an approved and permitted waste facility. Dirt roads inundated by project implementation would remain in place.

2.3.3 CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

CP1 consists primarily of enlarging Shasta Dam by raising the crest 6.5 feet and enlarging the reservoir by 256,000 acre-feet.

Major Components of CP1

CP1 includes the following major components:

- Raising Shasta Dam and appurtenant facilities by 6.5 feet
- Implementing the set of eight common management measures described above
- Implementing the common environmental commitments described above

By raising Shasta Dam 6.5 feet, from a crest elevation of 1,077.5 feet to 1,084.0 feet (based on the National Geodetic Vertical Datum 1929 (NGVD29)),[2] CP1 would increase the height of the reservoir full pool by 8.5 feet. The additional 2-foot increase in the height of the full pool above the dam raise height would result from spillway modifications, including replacing the three drum gates with six sloping, fixed-wheel gates. This increase in full pool height would add approximately 256,000 acre-feet of additional storage to the overall reservoir capacity. Accordingly, the overall full pool storage would increase from 4.55 million acre-feet (MAF) to 4.81 MAF. Table 2-6 summarizes major physical features associated with CP1.

[2] Dam crest elevations are based on NGVD29. All current feasibility-level designs and figures for Shasta Dam and appurtenant structures are based on NGVD29.

Table 2-6. Physical Features of Action Alternatives

Main Features		Action Alternatives				
	CP1	**CP2**	**CP3**	**CP4**	**CP4A**	**CP5**
Dam and Appurtenant Structures						
Shasta Dam						
Crest Raise (feet)	6.5	12.5	18.5	18.5	18.5	18.5
Full Pool Height Increase (feet)	8.5	14.5	20.5	20.5	20.5	20.5
Elevation of Dam Crest (feet)[1]	1084.0	1090.0	1096.0	1096.0	1096.0	1096.0
Elevation of Full Pool (feet)[2]	1,078.2	1,084.2	1,090.2	1,090.2	1,090.2	1,090.2
Capacity Increase (acre-feet)	256,000	443,000	634,000	634,000	634,000	634,000
Main Dam	Raise dam crest. Construct new parapets and utility gallery. Raise existing elevator tower and hoist tower.	Raise dam crest. Construct new parapets and utility gallery. Raise existing elevator tower and hoist tower.	Raise dam crest. Construct new parapets and utility gallery. Raise existing elevator tower and hoist tower.	Raise dam crest. Construct new parapets and utility gallery. Raise existing elevator tower and hoist tower.	Raise dam crest. Construct new parapets and utility gallery. Raise existing elevator tower and hoist tower.	Raise dam crest. Construct new parapets and utility gallery. Raise existing elevator tower and hoist tower.
Wing Dams	Raise to meet dam crest. Build new visitor center along left wing dam. Relocate gantry crane on right wing dam.	Raise to meet dam crest. Build new visitor center along left wing dam. Relocate gantry crane on right wing dam.	Raise to meet dam crest. Build new visitor center along left wing dam. Relocate gantry crane on right wing dam.	Raise to meet dam crest. Build new visitor center along left wing dam. Relocate gantry crane on right wing dam.	Raise to meet dam crest. Build new visitor center along left wing dam. Relocate gantry crane on right wing dam.	Raise to meet dam crest. Build new visitor center along left wing dam. Relocate gantry crane on right wing dam.
Spillway	Raise crest and extend piers. Replace 3 drum gates with 6 sloping fixed-wheel gates.	Raise crest and extend piers. Replace 3 drum gates with 6 sloping fixed-wheel gates.	Raise crest and extend piers. Replace 3 drum gates with 6 sloping fixed-wheel gates.	Raise crest and extend piers. Replace 3 drum gates with 6 sloping fixed-wheel gates.	Raise crest and extend piers. Replace 3 drum gates with 6 sloping fixed-wheel gates.	Raise crest and extend piers. Replace 3 drum gates with 6 sloping fixed-wheel gates.
River Outlets	Replace 4 lower-tier tube valves with jet flow gates.	Replace 4 lower-tier tube valves with jet flow gates.	Replace 4 lower-tier tube valves with jet flow gates.	Replace 4 lower-tier tube valves with jet flow gates.	Replace 4 lower-tier tube valves with jet flow gates.	Replace 4 lower-tier tube valves with jet flow gates.
Temperature Control Device	Raise/modify controls.	Raise/modify controls.	Raise/modify controls.	Raise/modify controls.	Raise/modify controls.	Raise/modify controls.
Shasta Powerplant/ Penstocks	Raise penstock hoists.	Raise penstock hoists.	Raise penstock hoists.	Raise penstock hoists.	Raise penstock hoists.	Raise penstock hoists.

Table 2-6. Physical Features of Action Alternatives (contd.)

Main Features	Action Alternatives					
	CP1	**CP2**	**CP3**	**CP4**	**CP4A**	**CP5**
Pit 7 Dam/ Powerhouse	Increase height of training walls on dam spillway. Install a tailwater depression system. Modify other Pit 7ancillary facilities.	Increase height of training walls on dam spillway. Install a tailwater depression system. Modify other Pit 7ancillary facilities.	Increase height of training walls on dam spillway. Install a tailwater depression system. Modify other Pit 7ancillary facilities.	Increase height of training walls on dam spillway. Install a tailwater depression system. Modify other Pit 7ancillary facilities.	Increase height of training walls on dam spillway. Install a tailwater depression system. Modify other Pit 7ancillary facilities.	Increase height of training walls on dam spillway. Install a tailwater depression system. Modify other Pit 7ancillary facilities.
Reservoir Area Clearing	Clear 150 acres completely and 220 acres with overstory removal.	Clear 240 acres completely and 350 acres with overstory removal.	Clear 340 acres completely and 500 acres with overstory removal.	Clear 340 acres completely and 500 acres with overstory removal.	Clear 340 acres completely and 500 acres with overstory removal.	Clear 340 acres completely and 500 acres with overstory removal.
Reservoir Area Dikes and Railroad Embankments	Construct 3 railroad embankments and 2 new dikes.	Construct 3 railroad embankments and 3 new dikes.	Construct 3 railroad embankments and 4 new dikes.	Construct 3 railroad embankments and 4 new dikes.	Construct 3 railroad embankments and 4 new dikes.	Construct 3 railroad embankments and 4 new dikes.
Relocations						
Roadways	Match replacement widths to existing paved roads to be replaced.	Match replacement widths to existing paved roads to be replaced.	Match replacement widths to existing paved roads to be replaced.	Match replacement widths to existing paved roads to be replaced.	Match replacement widths to existing paved roads to be replaced.	Match replacement widths to existing paved roads to be replaced.
Length of Relocated Roadway (linear feet)	16,700	28,400	33,100	33,100	33,100	33,100
Number of Road Segments Affected	10	21	30	30	30	30
Vehicle Bridges	Relocate 4 bridges, modify 1 bridge.	Relocate 4 bridges, modify 1 bridge.	Relocate 4 bridges, modify 1 bridge.	Relocate 4 bridges, modify 1 bridge.	Relocate 4 bridges, modify 1 bridge.	Relocate 4 bridges, modify 1 bridge.
Railroad	Relocate 2 bridges and realign track in-between, modify 1 bridge	Relocate 2 bridges and realign track in-between, modify 1 bridge	Relocate 2 bridges and realign track in-between, modify 1 bridge	Relocate 2 bridges and realign track in-between, modify 1 bridge	Relocate 2 bridges and realign track in-between, modify 1 bridge	Relocate 2 bridges and realign track in-between, modify 1 bridge

Table 2-6. Physical Features of Action Alternatives (contd.)

Main Features	Action Alternatives					
	CP1	CP2	CP3	CP4	CP4A	CP5
Recreation Facilities	Modify or replace 9 marinas, 6 public boat ramps, 6 resorts, 202 campsites/day-use sites/RV sites, 2 USFS facilities, 8.1 miles of trail, and 2 trailheads.	Modify or replace 9 marinas, 6 public boat ramps, 6 resorts, 261 campsites/ day-use sites/RV sites, 2 USFS facilities, 9.9 miles of trail, and 2 trailheads.	Modify or replace 9 marinas, 6 public boat ramps, 6 resorts, 328 campgrounds/day-use areas/RV sites, 2 USFS facilities, 11.6 miles of trail, and 2 trailheads.	Modify or replace 9 marinas, 6 public boat ramps, 6 resorts, 328 campgrounds/day-use areas/RV sites, 2 USFS facilities, 11.6 miles of trail, and 2 trailheads.	Modify or replace 9 marinas, 6 public boat ramps, 6 resorts, 328 campgrounds/day-use areas/RV sites, 2 USFS facilities, 11.6 miles of trail, and 2 trailheads.	Modify or replace 9 marinas, 6 public boat ramps, 6 resorts, 328 campgrounds/day-use areas/RV sites, 2 USFS facilities, 11.6 miles of trail, and 2 trailheads. Add 6 trailheads and18 miles of new hiking trails.
Utilities	Relocate inundated utilities. Construct wastewater treatment facilities.	Relocate inundated utilities. Construct wastewater treatment facilities.	Relocate inundated utilities. Construct wastewater treatment facilities.	Relocate inundated utilities. Construct wastewater treatment facilities.	Relocate inundated utilities. Construct wastewater treatment facilities.	Relocate inundated utilities. Construct wastewater treatment facilities.
Ecosystem Enhancements	None	None	None	Reserve 378 TAF of the additional storage for cold-water supply for anadromous fish. Implement adaptive management plan to benefit anadromous fish. Augment spawning gravel in the upper Sacramento River at the rate of up to 10,000 tons per year. Restore riparian, floodplain, and side channel habitat along the upper Sacramento River.	Reserve 191 TAF of the additional storage for cold-water supply for anadromous fish. Implement adaptive management plan to benefit anadromous fish. Augment spawning gravel in the upper Sacramento River at the rate of up to 10,000 tons per year. Restore riparian, floodplain, and side channel habitat along the upper Sacramento River.	Construct shoreline fish habitat around Shasta Lake. Enhance aquatic habitat in tributaries to Shasta Lake to improve fish passage. Augment spawning gravel in the upper Sacramento River at the rate of up to 10,000 tons per year. Restore riparian, floodplain, and side channel habitat along the upper Sacramento River.

Notes:

[1] Dam crest elevations are based on the National Geodetic Vertical Datum of 1929 (NGVD29). All current feasibility-level designs and figures for Shasta Dam and appurtenant structures are based on NGVD29.

[2] Full pool elevations are based on the North American Vertical Datum of 1988 (NAVD88), which is 2.66 feet higher than NGVD29. All current feasibility-level designs and figures for reservoir area infrastructure modifications and relocations to accommodate increased water levels are based on a 2001 aerial survey of the reservoir using NAVD88.

Key:
CP = comprehensive plan
RV = recreational vehicle
TAF = thousand acre-feet
USFS = U.S. Department of Agriculture, Forest Service

Under CP1, the additional storage in Shasta Reservoir would be used to increase water supply reliability and to expand the cold-water pool for downstream anadromous fisheries. This alternative (and all comprehensive plans) involves extending the existing TCD for efficient use of the expanded cold-water pool. Operations for water supply, hydropower, and environmental and other regulatory requirements would be similar to existing operations, except during dry and critical years when a portion of the increased storage capacity in Shasta Reservoir would be reserved to specifically focus on increasing M&I deliveries. In dry years, 70,000 acre-feet of the 256,000 acre-feet increased storage capacity in Shasta Reservoir would be reserved for increasing M&I deliveries. In critical years, 35,000 acre-feet of the increased storage capacity would be reserved for increasing M&I deliveries.

CP1 would also include the potential to revise the operational rules for flood control at Shasta Dam and Reservoir, which could reduce the potential for flood damage, and benefit recreation. Although the volume of the flood control pool would remain the same as under existing operations (1.3 MAF), the bottom of the flood control pool elevation would likely be increased based on increased dam height and reservoir capacity. Because of reservoir geometry, this would decrease the depth of the flood control pool, allowing higher winter and spring water levels. Increased reservoir capacity could have further flood damage reduction benefits in years when water levels are below the new flood control pool elevation.

In some years, when the flood control requirements guided reservoir releases, potential would also exist for changes in flood control rules to allow more operational flexibility in reservoir drawdown requirements in response to storms, resulting in a net increase in the rate of spring reservoir filling during some years.

In addition, higher spring water levels, reduced drawdown (distance to water) during the recreation season, and associated increases in reservoir surface area would benefit recreation.

Potential Benefits of CP1

Major potential benefits of CP1, related to contributions to the project objectives and broad public services, are described below.

Increase Anadromous Fish Survival Water temperature is one of the most important factors affecting anadromous fish survival in the Sacramento River. CP1 would increase the ability of Shasta Dam to make cold-water releases and regulate water temperatures for fish in the upper Sacramento River, primarily in dry and critical water years. This would be accomplished by raising Shasta Dam 6.5 feet, thus increasing the depth of the cold-water pool in Shasta Reservoir and resulting in an increase in seasonal cold-water volume below the thermocline (layer of greatest water temperature and density change). Cold water released from Shasta Dam significantly influences water temperature conditions in the Sacramento River between Keswick Dam and the RBPP. Hence, the most significant water temperature benefits to anadromous fish would occur upstream from the RBPP. It is estimated that under CP1, improved water temperature and flow conditions could result in an average annual increase in the salmon population of about 61,300 out-migrating juvenile Chinook salmon.

Increase Water Supply Reliability CP1 would increase water supply reliability by increasing water supplies for CVP and SWP irrigation and M&I deliveries. This action would contribute to replacement of supplies redirected to other purposes in the CVPIA. CP1 would help reduce estimated future water shortages by increasing dry and critical year water supplies for agricultural and M&I deliveries by at least 47,300 acre-feet per year and average annual deliveries by about 31,000 acre-feet per year. The majority of increased dry and critical year water supplies (42,700 acre-feet) would be for south-of-Delta agricultural and M&I deliveries. In addition, water use efficiency could help reduce current and future water shortages by allowing a more effective use of existing supplies. As population and resulting water demands continue to grow and available supplies continue to remain relatively static, more effectively using these supplies could reduce potential critical impacts on agricultural and urban areas resulting from water shortages. Under CP1, approximately $1.6 million would be allocated over an initial 10-year period to fund agricultural and M&I water conservation programs, focused on agencies benefiting from increased reliability of project water supplies.

Develop Additional Hydropower Generation Higher water surface elevations in the reservoir would result in an increase in power generation of about 52 gigawatt-hours (GWh) per year. This generation value is the expected increased generation from Shasta Dam and other CVP/SWP facilities. Other power benefits include additional capacity (i.e., the rate at which power can be generated) and ancillary services, which provide the ability to manage the electric grid in a reliable manner.

Maintain and Increase Recreation Opportunities CP1 includes features to at least maintain the existing recreation capacity at Shasta Lake. Although CP1 does not include specific features to further increase recreation capacity, benefits to the water-oriented recreation experience at Shasta Lake would likely occur because of the increase in average lake surface area, reduced drawdown during the recreation season, and modernization of recreation facilities. The maximum surface area of the lake would increase by about 1,110 acres (4 percent), from 29,700 acres to about 30,800 acres. The average surface area of the lake during the recreation season from May through September would increase by about 800 acres (3 percent), from 23,900 acres to 24,700 acres. There would also be limited potential to provide additional benefits to recreation by allowing more reliable filling of the reservoir during the spring.

Benefits Related to Other Project Objectives CP1 could also provide benefits related to flood damage reduction, ecosystem restoration, and water quality. Enlarging Shasta Dam would provide for incidental increased reservoir capacity to capture flood flows, which could reduce flood damage along the upper Sacramento River. Improved fisheries conditions as a result of CP1, as described above, and increased flexibility to meet flow and temperature requirements, could also enhance overall ecosystem resources in the Sacramento River. For example, CP1 would result in improved flow and water temperature conditions, particularly during drought periods, in the upper Sacramento River for other resident fish species, such as the Sacramento splittail. Furthermore, CP1 could potentially benefit ecosystem restoration through improved Delta water quality conditions by increasing Delta outflow during drought years and reducing salinity during critical periods. CP1 may also contribute to improving Delta water quality through increased Delta emergency response capabilities. When Delta emergencies occur, additional water in Shasta Reservoir could improve operational flexibility for increasing releases to supplement existing water sources to reestablish Delta water quality. In addition to Delta emergency response, increased storage in Shasta Reservoir could increase emergency response capability for CVP/SWP water supply deliveries.

Construction for CP1

Construction activities associated with physical features under CP1 would include land-based construction activities associated with the following:

- Clearing vegetation from portions of the inundated reservoir area
- Constructing the dam raise, appurtenant structures, reservoir area dikes, and railroad embankments
- Relocating roadways, bridges, recreation facilities, utilities, and miscellaneous minor infrastructure

Construction activities for CP1 are described in Section 2.3.8, "Comprehensive Plan Construction Activities."

Operations and Maintenance for CP1

Shasta Dam is operated in conjunction with other CVP facilities and SWP facilities to manage floodwater, storage of surplus winter runoff for irrigation in the Sacramento and San Joaquin valleys, M&I use, maintenance of navigation flows, protection and conservation of fish in the Sacramento River and Delta, and generation of hydroelectric energy. Storage in Shasta Reservoir fluctuates greatly throughout the year; storage is typically highest in April and May, as the need for flood control reservation space in the reservoir decreases. Storage is typically at its lowest in September and October, after the irrigation season and before winter refill begins. Shasta Reservoir capacity is currently 4.55 MAF, with a maximum objective release capacity of 79,000 cubic feet per second (cfs). Storage levels are lowest by October to provide sufficient flood risk reduction and capture capacity during the following wet months. The storage target gradually increases beginning in October to full pool in May; storage is then withdrawn for high water demand (e.g., agricultural, M&I, fishery, and water quality uses) during summer.

A series of rules and regulations in the form of flood control requirements, flow requirements, water quality requirements, and water supply commitments governs operations at Shasta Dam. Federal and State laws, regulations, standards, and plans regulating Shasta Dam operations are described in detail in Chapter 6, “Hydrology, Hydraulics, and Water Management,” and include the following:

- 2009 NMFS BO (NMFS 2009)
- 2008 USFWS BO (USFWS 2008)
- CVPIA PEIS (Reclamation 1999)
- CVP long-term water service contracts (see the Hydrology, Hydraulics, and Water Management Technical Report, Table 1-25, in the Physical Resources Appendix)
- Trinity River ROD (Reclamation 2000)
- Reclamation’s 2008 Long-Term Operation BA (Reclamation 2008)
- Flood management requirements in accordance with the Water Control Manual (USACE 1977)
- State Water Resources Control Board (State Water Board) Water Right Orders 90-05 and 91-01
- California Department of Fish and Game (CDFG) and Reclamation Memorandum of Agreement (CDFG and Reclamation 1960)
- Water Quality Control Plan for the San Francisco Bay/San Joaquin Delta Estuary (State Water Board 1995)
- State Water Board Water Right Revised Decision 1641 (State Water Board 2000)
- CVP and SWP Coordinated Operations Agreement (Reclamation and DWR 1986)

In addition, Shasta Dam and Reservoir are operated according to the *Standing Operating Procedures for Shasta Dam and Reservoir*. However, due to sensitivity regarding this information, including security and public health and safety concerns, this document is not available to the general public.

Under CP1, the additional storage would be retained to increase water supply reliability and to expand the cold-water pool in Shasta Reservoir for fisheries benefits. Shasta Dam operational guidelines would continue unchanged, except during dry and critical years, when 70,000 acre-feet and 35,000 acre-feet, respectively, of the 256,000 acre-feet increased storage capacity in Shasta Reservoir would be operated primarily to increase M&I deliveries. Operations targeting increased M&I deliveries were based on existing and anticipated future demands, operational priorities, and facilities of the SWP, which provides M&I water to a majority of the State's population. For this EIS, these operations were simulated in CalSim-II by using the reserved storage capacity to provide deliveries for previously unmet SWP demands during dry and critical years. For CP1, existing water quality and temperature requirements would typically be met in most years; therefore, additional water in storage would be released primarily for water supply purposes. Accordingly, minimal increases in flow would be expected in months when Delta exports were constrained, or when flow was not required for water supply purposes.

In comparison to current operations, CP1 would store some additional flows behind Shasta Dam during periods when downstream needs would have already been met, but flows would have been released because of storage limitations. The resulting increase in storage would be released downstream when there were opportunities for beneficial use of the water, either to meet water supply reliability demands or to improve Reclamation's abilities to meet its environmental objectives. The additional water in storage would also expand the cold-water pool and increase end-of-September carryover storage in Shasta Reservoir, increasing the ability of Shasta Dam to improve water temperatures for anadromous fish in the upper Sacramento River.

Conversely, if water in storage were insufficient to meet all of the project purposes, the first increment to be reduced would be deliveries to water service contractors. Releases from Shasta Dam under CP1 would typically increase in the summer months, corresponding with the periods of greatest agricultural demands. Similarly, releases would be reduced in the winter months, when the increased storage space could be used to capture additional runoff rather than releasing water to the downstream river, as would occur under Shasta Reservoir's current operations.

Maintenance of facilities related to the proposed dam and reservoir enlargement would be similar to maintenance activities currently conducted at Shasta Dam and Reservoir.

Operation of pumping facilities downstream from Shasta Dam would vary slightly from current operations and would result in higher costs. In addition, Reclamation would provide in kind power to offset the reduced generation at Pit 7 Dam and related facilities.

2.3.4 CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

CP2 consists primarily of enlarging Shasta Dam by raising the crest 12.5 feet and enlarging the reservoir by 443,000 acre-feet.

Major Components of CP2

CP2 includes the following major components:

- Raising Shasta Dam and appurtenant facilities by 12.5 feet.
- Implementing the set of eight common management measures previously described.
- Implementing the common environmental commitments previously described.

A dam raise of 12.5 feet was chosen because it represents a midpoint between the likely smallest dam raise considered and the largest practical dam raise that would not require relocating the Pit River Bridge. By raising Shasta Dam from a crest elevation of 1,077.5 feet to 1,090.0 feet (based on NGVD29), CP2 would increase the height of the reservoir's full pool by 14.5 feet. The additional 2-foot increase in the height of the full pool above the dam raise height would result from spillway modifications similar to the modifications proposed under CP1. This increase in full pool height would add approximately 443,000 acre-feet of storage to the reservoir's capacity. Accordingly, storage in the overall full pool would increase from 4.55 MAF to 5.0 MAF. Table 2-6 summarizes major physical features associated with CP2.

Under CP2, the additional storage in Shasta Reservoir would be used to increase water supply reliability and to expand the cold-water pool for downstream anadromous fisheries. The existing TCD would also be extended for efficient use of the expanded cold-water pool. Operations for water supply, hydropower, and environmental and other regulatory requirements would be similar to existing operations, except during dry and critical years when a portion of the increased storage in Shasta Reservoir would be reserved to specifically focus on increasing M&I deliveries. In dry years, 120,000 acre-feet of the 443,000 acre-feet increased storage capacity in Shasta Reservoir would be reserved for increasing M&I deliveries. In critical years, 60,000 acre-feet of the increased storage capacity would be reserved for increasing M&I deliveries.

As described for CP1, this alternative would also include the potential to revise flood control operational rules, which could reduce the potential for flood damage and benefit recreation.

Potential Benefits of CP2

Major potential benefits of CP2, related to contributions to the project objectives, are described below.

Increase Anadromous Fish Survival Water temperature is one of the most important factors affecting anadromous fish survival in the Sacramento River. CP2 would increase the ability of Shasta Dam to make cold-water releases and regulate water temperatures for fish in the upper Sacramento River, primarily in dry and critical water years. This would be accomplished by raising Shasta Dam 12.5 feet, thus increasing the depth of the cold-water pool in Shasta Reservoir and resulting in an increase in seasonal cold-water volume below the thermocline (layer of greatest water temperature and density change). Cold water released from Shasta Dam significantly influences water temperature conditions in the Sacramento River between Keswick Dam and the RBPP. Hence, the most significant water temperature benefits to anadromous fish would occur upstream from the RBPP. It is estimated that improved water temperature and flow conditions under CP2 could result in an average annual increase in the salmon population of about 379,200 out-migrating juvenile Chinook salmon.

Increase Water Supply Reliability CP2 would increase water supply reliability by increasing water supplies for CVP and SWP irrigation and M&I deliveries. This action would contribute to replacement of supplies redirected to other purposes in the CVPIA. CP2 would help reduce estimated future water shortages by increasing the reliability of dry and critical year water supplies for agricultural and M&I deliveries by at least 77,800 acre-feet per year and average annual deliveries by about 51,300 acre-feet per year. The majority of increased dry and critical year water supplies (67,100 acre-feet) would be for south-of-Delta agricultural and M&I deliveries. In addition, water use efficiency could help reduce current and future water shortages by allowing a more effective use of existing supplies. As population and resulting water demands continued to grow and available supplies continued to remain relatively static, more effectively using these supplies could reduce potential critical impacts on agricultural and urban areas resulting from water shortages. Under CP2, approximately $2.6 million would be allocated over an initial 10-year period to fund agricultural and M&I water conservation programs, focused on agencies benefiting from increased reliability of project water supplies.

Develop Additional Hydropower Generation Higher water surface elevations in the reservoir would result in a net increase in power generation of about 87 GWh per year. This generation value is the expected increased generation from Shasta Dam and other CVP/SWP facilities. Other power benefits include additional capacity (i.e., the rate at which power can be generated) and ancillary services, which provide the ability to manage the electric grid in a reliable manner.

Maintain and Improve Recreation Opportunities CP2 includes features to, at minimum, maintain the existing recreation capacity at Shasta Lake. Although CP2 does not have specific features to further increase recreation capacity, benefits to the water-oriented recreation experience at Shasta Lake would likely occur because of the increase in average lake surface area, reduced drawdown during the recreation season, and modernization of recreation facilities. The maximum surface area of the lake would increase by about 1,900 acres (6 percent), from 29,700 acres to about 31,600 acres. The average surface area of the lake during the recreation season from May through September would increase by about 1,300 acres (5 percent), from 23,900 acres to 25,200 acres. There would also be limited potential to provide additional benefits to recreation by allowing more reliable filling of the reservoir during the spring.

Benefits Related to Other Project Objectives CP2 could also provide benefits related to flood damage reduction, ecosystem restoration, and water quality, as described for CP1, but to a greater extent because of increased capacity and associated overall system flexibility.

Construction for CP2

Construction activities associated with physical features under CP2 would include land-based construction activities associated with the following:

- Clearing vegetation from portions of the inundated reservoir area
- Constructing the dam raise, appurtenant structures, reservoir area dikes, and railroad embankments
- Relocating roadways, bridges, recreation facilities, utilities, and miscellaneous minor infrastructure

Construction activities for CP2 are described in Section 2.3.8, "Comprehensive Plan Construction Activities."

Operations and Maintenance for CP2

Operations under CP2 would be governed by the same regulatory constraints as described for CP1. Similar to CP1, the additional storage would be retained to increase water supply reliability and to expand the cold-water pool in Shasta Reservoir for fisheries benefits. Shasta Dam operational guidelines would continue unchanged, except during dry years and critical years, when 120,000 acre-feet and 60,000 acre-feet, respectively, of the 443,000 acre-feet increased storage capacity in Shasta Reservoir would be operated primarily to increase M&I deliveries. Operations targeting increased M&I deliveries were based on existing and anticipated future demands, operational priorities, and facilities of the SWP. For CP2, existing water quality and temperature requirements would typically be met in most years; therefore, additional water in storage would be released primarily for water supply purposes. Accordingly, minimal increases in flow would be expected in months when Delta exports were constrained, or when flow was not usable for water supply purposes.

In comparison to current operations, CP2 would store some additional flows behind Shasta Dam during periods when downstream needs would have already been met, but flows would have been released because of storage limitations.

The resulting increase in storage would be released downstream when there were opportunities for beneficial use of the water, either to meet water supply reliability demands or to improve Reclamation's abilities to meet its environmental objectives. The additional water in storage would also expand the cold-water pool and increase end-of-September carryover storage in Shasta Reservoir, increasing the ability of Shasta Dam to improve water temperatures for anadromous fish in the upper Sacramento River.

Conversely, if water in storage were insufficient to meet all of the project purposes, the first increment to be reduced would be deliveries to water service contractors. Releases from Shasta Dam under CP2 would typically increase in the summer months, corresponding with the periods of greatest agricultural demands. Similarly, releases would be reduced in the winter months, when the increased storage space could be used to capture additional runoff rather than releasing water to the downstream river, as would occur with Shasta Reservoir's current operations.

Maintenance of facilities related to the proposed dam and reservoir enlargement would be similar to maintenance activities currently conducted at Shasta Dam and Reservoir.

Operation of pumping facilities downstream from Shasta Dam would vary slightly from current operations and would result in higher costs. In addition, Reclamation would provide in-kind power to offset reduced generation at Pit 7 Dam and related facilities.

2.3.5 CP3 – 18.5-Foot Dam Raise, Agricultural Water Supply Reliability and Anadromous Fish Survival

CP3 focuses on increasing agricultural water supply reliability and increasing anadromous fish survival by raising Shasta Dam 18.5 feet and enlarging Shasta Reservoir by 634,000 acre-feet.

Major Components of CP3

CP3 includes the following major components:

- Raising Shasta Dam and appurtenant facilities by 18.5 feet
- Implementing the set of eight common management measures previously described
- Implementing the common environmental commitments previously described

By raising Shasta Dam 18.5 feet, from a crest elevation of 1,077.5 feet to 1,096.0 feet (based on NGVD29), CP3 would increase the height of the reservoir full pool by 20.5 feet. The additional 2-foot increase in the height of the full pool above the dam raise height would result from spillway modifications similar to the modifications proposed under CP1. This increase in full pool height would add approximately 634,000 acre-feet of storage to the reservoir's capacity. Accordingly, storage in the overall full pool would increase from 4.55 MAF to 5.19 MAF. Although higher dam raises are technically and physically feasible, 18.5 feet is the largest dam raise that would not require extensive and costly reservoir area relocations, such as relocating the Pit River Bridge, Interstate 5 (I-5), and the Union Pacific Railroad (UPRR) tunnels. Table 2-6 summarizes major physical features associated with CP3.

Because CP3 focuses on increasing agricultural water supply reliability and anadromous fish survival, none of the increased storage capacity in Shasta Reservoir would be reserved for increasing M&I deliveries. Operations for water supply, hydropower, and environmental and other regulatory requirements would be similar to existing operations. The additional storage would be retained for water supply reliability and to expand the cold-water pool for downstream anadromous fisheries. The existing TCD would also be extended for efficient use of the expanded cold-water pool.

As described for the above alternatives, this alternative would also include the potential to revise flood control operational rules, which could reduce the potential for flood damage and benefit recreation.

Potential Benefits of CP3

Major potential benefits of CP3, related to contributions to the project objectives, are described below.

Increase Anadromous Fish Survival Water temperature is one of the most important factors affecting anadromous fish survival in the Sacramento River. CP3 would increase the ability of Shasta Dam to make cold-water releases and regulate water temperatures for fish in the upper Sacramento River, primarily in dry and critical water years. This would be accomplished by raising Shasta Dam 18.5 feet, thus increasing the depth of the cold-water pool in Shasta Reservoir and resulting in an increase in seasonal cold-water volume below the thermocline (layer of greatest water temperature and density change). Cold water released from Shasta Dam significantly influences water temperature conditions in the Sacramento River between Keswick Dam and the RBPP. Hence, the most significant water temperature benefits to anadromous fish would occur upstream from the RBPP. It is estimated that improved water temperature and flow conditions under CP3 could result in an average annual increase in the Chinook salmon population of about 207,400 out-migrating juvenile fish.

Increase Water Supply Reliability CP3 would increase water supply reliability by increasing water supplies for CVP irrigation deliveries. This action would contribute to replacement of supplies redirected to other purposes in the CVPIA. CP3 would help reduce estimated future water shortages by increasing the reliability of dry and critical year water supplies for agricultural deliveries by at least 63,100 acre-feet per year and average annual deliveries by about 61,700 acre-feet per year. Almost half of the increased dry and critical year water supplies (28,000 acre-feet) would be for south-of-Delta agricultural deliveries, with the remainder for north-of-Delta agricultural deliveries. In addition, water use efficiency could help reduce current and future water shortages by allowing a more effective use of existing supplies. As population and resulting water demands continued to grow and available supplies continued to remain relatively static, more effectively using these supplies could reduce potential critical impacts to agricultural and urban areas resulting from water shortages. Under CP3, approximately $3.1 million would be allocated over an initial 10-year period to fund agricultural water conservation programs, focused on agencies benefiting from increased reliability of project water supplies.

Develop Additional Hydropower Generation Higher water surface elevations in the reservoir would result in a net increase in power generation of about 86 GWh per year. This generation value is the expected increased generation from Shasta Dam and other CVP/SWP facilities. Other power benefits include additional capacity (i.e., the rate at which power can be generated) and ancillary services, which provide the ability to manage the electric grid in a reliable manner.

Maintain and Increase Recreation Opportunities CP3 includes features to, at a minimum, maintain the existing recreation capacity at Shasta Lake. Although CP3 does not include specific features to further increase recreation capacity, benefits to the water-oriented recreation experience at Shasta Lake would likely occur because of the increase in average lake surface area, reduced drawdown during the recreation season, and modernization of recreation facilities. The maximum surface area of the lake would increase by about 2,600 acres (9 percent), from 29,700 acres to about 32,300 acres. The average surface area of the lake during the recreation season from May through September would increase by about 2,000 acres (8 percent), from 23,900 acres to 25,900 acres. There would also be limited potential for reservoir reoperation to provide additional benefits to recreation by allowing more reliable filling of the reservoir during the spring.

Benefits Related to Other Project Planning Objectives CP3 could also provide benefits related to flood damage reduction, ecosystem restoration, and water quality, as described for CP1, but to a greater extent because of increased capacity and associated overall system flexibility.

Construction for CP3

Construction activities associated with physical features under CP3 would include land-based construction activities associated with the following:

- Clearing vegetation from portions of the inundated reservoir area

- Constructing the dam raise, appurtenant structures, reservoir area dikes, and railroad embankments
- Relocating roadways, bridges, recreation facilities, utilities, and miscellaneous minor infrastructure

Construction activities for CP3 are described in Section 2.3.8, "Comprehensive Plan Construction Activities."

Operations and Maintenance for CP3

Operations under CP3 would be governed by the same regulatory constraints as described for CP1. Under CP3, Shasta Dam operational guidelines would continue unchanged, with the additional storage retained for agricultural water supply reliability and to expand the cold-water pool in Shasta Reservoir for fisheries benefits. Unlike CP1 and CP2, none of the increased storage space in Shasta Reservoir would be reserved for increasing M&I deliveries under CP3. Existing water quality and temperature requirements would be met in most years; therefore, additional water in storage would be released primarily for water supply purposes. Accordingly, minimal increases in flow would be expected in months when Delta exports were constrained, or when flow was not usable for water supply purposes.

In comparison to current operations, CP3 would store some additional flows behind Shasta Dam during periods when downstream needs would have already been met, but flows would have been released because of storage limitations. The resulting increase in storage would be released downstream when there were opportunities for beneficial use of the water, either to meet water supply reliability demands or to improve Reclamation's abilities to meet its environmental objectives. The additional water in storage would also expand the cold-water pool and increase end-of-September carryover storage in Shasta Reservoir, increasing the ability of Shasta Dam to improve water temperatures for anadromous fish in the upper Sacramento River.

Conversely, if water in storage were insufficient to meet all of the project purposes, the first increment to be reduced would be deliveries to water service contractors. Releases from Shasta Dam under CP3 would typically increase in the summer months, corresponding with the periods of greatest agricultural demands. Similarly, releases would be reduced in the winter months, when the increased storage space could be used to capture additional runoff rather than releasing water to the downstream river, as would occur with Shasta Reservoir's current operations.

Maintenance of facilities related to the proposed dam and reservoir enlargement would be similar to maintenance activities currently conducted at Shasta Dam and Reservoir.

Operation of pumping facilities downstream from Shasta Dam would vary slightly from current operations and would result in higher costs. In addition, Reclamation would provide in-kind power to offset reduced generation at Pit 7 Dam and related facilities.

2.3.6 CP4 and CP4A – 18.5-Foot Dam Raise, Anadromous Fish Focus with Water Supply Reliability

CP4 and CP4A focus on increasing anadromous fish survival by raising Shasta Dam 18.5 feet while also increasing water supply reliability. CP4 and CP4A are identical except for Shasta Dam and reservoir operations. CP4 and CP4A would have similar reservoir operations in that they each dedicate a portion of the new storage in Shasta Lake for fisheries purposes; however, the portion of this dedicated storage varies.

Major Components of CP4 and CP4A

CP4 and CP4A include the following major components:

- Raising Shasta Dam and appurtenant facilities by 18.5 feet
- Reserving a portion of the increased storage in Shasta Lake for maintaining cold-water volume or augmenting flows as part of an adaptive management plan for anadromous fish survival (378,000 acre-feet for CP4, 191,000 acre-feet for CP4A)
- Augmenting spawning gravel in the upper Sacramento River
- Restoring riparian, floodplain, and side channel habitat in the upper Sacramento River
- Implementing the set of eight common management measures previously described
- Implementing the common environmental commitments previously described

By raising Shasta Dam 18.5 feet, from a crest elevation of 1,077.5 feet to 1,096.0 feet (based on NGVD29), CP4 or CP4A would increase the height of the reservoir full pool by 20.5 feet. The additional 2-foot increase in the height of the full pool above the dam raise height would result from spillway modifications similar to the modifications proposed under CP1. This increase in full pool height would add approximately 634,000 acre-feet of storage to the reservoir's capacity. Accordingly, storage in the overall full pool would be increased from 4.55 MAF to 5.19 MAF.

The additional storage created by the 18.5-foot dam raise would be used to improve the ability to meet temperature objectives and habitat requirements for anadromous fish during drought years and increase water supply reliability. Of the increased reservoir storage space of CP4, about 378,000 acre-feet would be dedicated to increasing the supply of cold water for anadromous fish survival purposes. Of the increased storage space of CP4A, about 191,000 acre-feet would be dedicated to increasing the supply of cold water for anadromous fish survival purposes. Table 2-6 summarizes major physical features associated with CP4 and CP4A.

The existing TCD would also be extended to achieve efficient use of the expanded cold-water pool for CP4 or CP4A. For CP4, operations for the remaining portion of increased storage (approximately 256,000 acre-feet) would be the same as in CP1, with 70,000 acre-feet reserved in dry years and 35,000 acre-feet reserved in critical years to specifically focus on increasing M&I deliveries. For CP4A, operations for the remaining portion of increased storage (approximately 443,000 acre-feet) would be the same as in CP2, with 120,000 acre-feet reserved in dry years and 60,000 acre-feet reserved in critical years to specifically focus on increasing M&I deliveries.

As described for the above alternatives, both CP4 and CP4A include the potential to revise the operational rules for flood control for Shasta Dam and Reservoir, which could reduce the potential for flood damage and benefit recreation.

CP4 and CP4A also include an adaptive management plan for the cold-water pool, and augmenting spawning gravel and restoring riparian, floodplain, and side channel habitat at one or more sites in the upper Sacramento River.

Adaptive Management of Cold-Water Pool The adaptive management plan may include operational changes to the timing and magnitude of releases from Shasta Dam to benefit anadromous fish, as long as there were no conflicts with current operational guidelines or adverse impacts on water supply reliability. Adaptive management of the cold-water pool for anadromous fish is discussed further below under "Operations and Maintenance for CP4 and CP4A."

Augment Spawning Gravel in Upper Sacramento River Gravel suitable for spawning has been identified as a significant influencing factor in the recovery of anadromous fish populations in the Sacramento River (USFWS 2001, NMFS 2014). Under CP4 and CP4A, spawning-sized gravel would be placed at multiple locations along the Sacramento River between Keswick Dam and the RBPP.

Gravel augmentation would occur at one to three locations every year, for a period of 10 years, unless unusual conditions or agency requests precluded placement during a single year. This program, in addition to the ongoing CVPIA gravel augmentation program, would help address the gravel deficit in the upper Sacramento River. However, this reach may continue to be gravel-limited in the future. Therefore, the proposed gravel augmentation program would be reevaluated after the 10-year period to assess the need for continued spawning gravel augmentation, and to identify opportunities for future gravel augmentation actions or programs.

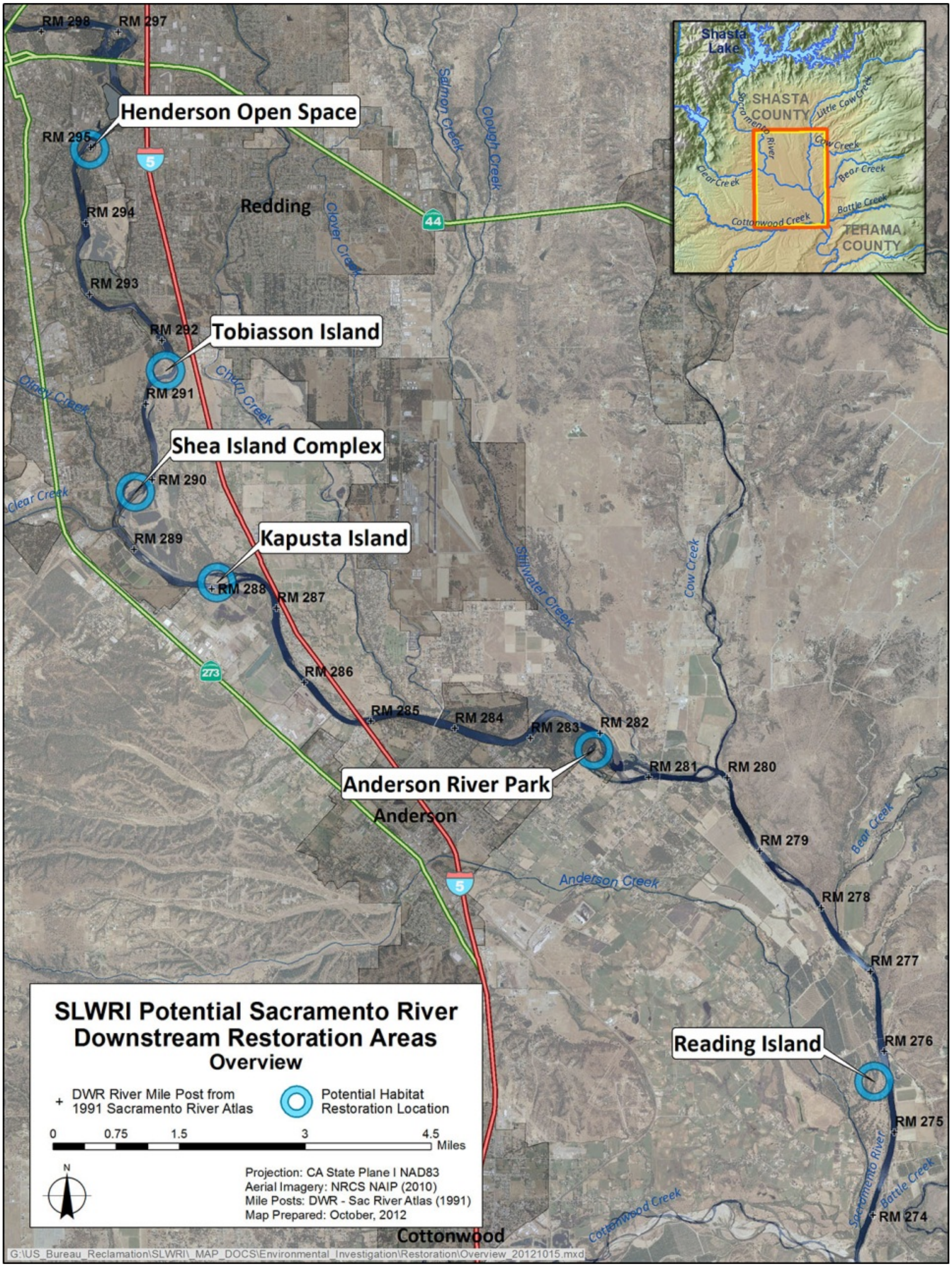
On average, 5,000 to 10,000 tons of gravel would be placed each year, although the specific quantity of gravel placed in a given year may vary from that range. Gravel would be obtained as uncrushed, rounded river rock, free of debris and organic material, from local, commercial sources. To maximize the benefit to anadromous fish, gravel would be washed and sorted to meet specific size criteria. To minimize impacts on salmonid spawning activity, gravel placement within the active river channels would occur between August and September each year, consistent with the time frame for the ongoing CVPIA gravel augmentation program.

Fifteen preliminary locations for spawning gravel augmentation were identified in the Sacramento River between Keswick Dam and Shea Island. Each site would be eligible for gravel placement one or more times during the 10-year program. Selection of these locations was based on potential benefits to anadromous fish and site accessibility. Gravel placement would provide either immediate spawning habitat or long-term recruitment.

Although preliminary sites have been identified, specific gravel augmentation site(s) and volume(s) would be selected each year in the spring or early summer through discussions among Reclamation, USFWS, CDFW, and NMFS. The discussions would include topics such as avoiding redundancy with planned CVPIA gravel augmentation activities in a given year; identifying hydrology or morphology issues that could affect the potential benefit of placing gravel at any particular site; identifying changes in spawning trends based on ongoing CVPIA monitoring efforts; evaluating potential new sites; and appropriately distributing selected gravel sites along the river reach(es).

Restore Riparian, Floodplain, and Side Channel Habitat Under CP4 and CP4A, riparian, floodplain, and side channel habitat restoration would occur at one or a combination of potential locations along the upper Sacramento River. Restoration measures for six potential sites, referred to collectively as “upper Sacramento River restoration sites,” are described below. The sites under consideration for habitat restoration are shown in Figure 2-4.

Henderson Open Space The City of Redding Henderson Open Space area is located south of Cypress Bridge on the east side of the Sacramento River at River Mile (RM) 295. Riparian and side channel restoration at the Henderson Open Space site could consist of enhancing an existing side channel to activate the frequency and duration of flows for Chinook salmon spawning habitat throughout the side channel. This potential modification would create up to 2,000 more linear feet of spawning habitat near areas of the Sacramento River that are actively used by anadromous fish for spawning.



Key: DWR = California Department of Water Resources

Figure 2-4. Potential Sacramento River Habitat Restoration Areas

Tobiasson Island Tobiasson Island is located downstream from South Bonnyview Bridge in the center of the Sacramento River at RM 292. Riparian, floodplain, and side channel habitat enhancement at this site would involve creating a side channel through the island to be activated at Sacramento River flows for Chinook salmon spawning. Riparian vegetation would be established along the course of the new side channel, adding approximately 1,350 linear feet of spawning and floodplain habitat to this section of the Sacramento River.

Shea Island Complex The Shea Island Complex is located on the west side of the Sacramento River upstream from the river's confluence with Clear Creek at RM 291. Restoration at the Shea Island Complex to improve side channel, riparian, and floodplain habitat would involve enhancing a major side channel through the site to keep the side channel hydraulically connected with the main stem of the Sacramento River at a broader range of flows. Adding channel complexity and enhancing riparian vegetation throughout the length of the side channel would improve Chinook salmon habitat along an additional 1,930 feet of the Sacramento River.

Kapusta Island Kapusta Island is located adjacent to the Kapusta Open Space area upstream from the I-5 crossing of the Sacramento River at RM 288. Restoration of riparian, side channel and floodplain habitat at Kapusta Island would involve enhancing an existing side channel by allowing it to carry water at a broader range of flows specifically to increase spawning habitat for winter-run and spring-run Chinook salmon. Allowing flow through the island, and increasing floodplain habitat would increase potential spawning habitat in this area of the river by about 1,590 linear feet.

Anderson River Park Anderson River Park is an open space area on the south bank of the Sacramento River downstream from Churn Creek, and upstream from the Deschutes Road crossing at RM 283. Restoration at this site would involve hydraulically reconnecting a remnant Sacramento River side channel with the Sacramento River. Regularly flowing water throughout the length of this side channel would increase anadromous fish rearing habitat along 4,750 feet of side channel in this section of the river.

Reading Island Reading Island lies along the Sacramento River just north of Cottonwood Creek at RM 274. The channel for Anderson Creek, a remnant Sacramento River side channel, defines the western edge of Reading Island. Construction of a levee on Anderson Creek has blocked the channel's connectivity with the Sacramento River and has created Anderson Slough, an area of still water. Riparian, floodplain, and side channel restoration on Reading Island would involve restoring flows in Anderson Creek and through Anderson Slough. These activities, alongside removal of invasive aquatic vegetation in the channel and reestablishment of riparian vegetation would aid in restoring rearing habitat for winter-run Chinook, and spawning habitat for steelhead along 4,225 feet of channel in this area of the river.

Potential Benefits of CP4 and CP4A

Major potential benefits of CP4 and CP4A, related to the project objectives, are described below.

Increase Anadromous Fish Survival Water temperature is one of the most important factors affecting anadromous fish survival in the Sacramento River. CP4 or CP4A would significantly increase the ability of Shasta Dam to make cold-water releases and regulate water temperature in the upper Sacramento River, primarily in dry and critical water years. This would be accomplished by raising Shasta Dam 18.5 feet, thus increasing the depth of the cold-water pool in Shasta Reservoir and resulting in an increase in seasonal cold-water volume below the thermocline (layer of greatest water temperature and density change). Cold water released from Shasta Dam significantly influences water temperature conditions in the Sacramento River between Keswick Dam and the RBPP. Hence, the most significant water temperature benefits to anadromous fish would occur upstream from the RBPP.

It is estimated that improved water temperature and flow conditions under CP4 could result in an average annual increase in Chinook salmon population of nearly 812,600 out-migrating juvenile fish. It is estimated that improved water temperature and flow conditions under CP4A could result in an average annual increase in Chinook salmon population of nearly 710,000 out-migrating juvenile fish.

Under CP4 and CP4A, an increase in the cold-water pool would allow Reclamation to operate Shasta Reservoir to provide not only a more reliable source of water during dry and critical water years, but also to provide more cool water for release into the Sacramento River to improve conditions for anadromous fish. Of the increased storage space for CP4, about 378,000 acre-feet (60 percent) would be dedicated to increasing the cold-water supply for anadromous fish survival purposes. Of the increased storage space for CP4A, about 191,000 acre-feet (30 percent) would be dedicated to increasing the cold-water supply for anadromous fish survival purposes.

In addition, CP4 and CP4A include a gravel augmentation program. Gravel augmentation would occur on average at one or more locations in the Sacramento River between Keswick Dam and the RBPP for a period of 10 years. On average, 5,000 to 10,000 tons of gravel would be placed each year, although the specific quantity of gravel placed in a given year may vary from that range. Spawning gravel augmentation is expected to positively influence anadromous fish populations in the Sacramento River.

Potential benefits to anadromous fish survival through conserving, restoring, and enhancing ecosystem resources are described below.

Increase Water Supply Reliability CP4 or CP4A would increase water supply reliability by increasing water supplies for CVP and SWP irrigation and

M&I deliveries. This action would contribute to replacement of supplies redirected to other purposes in the CVPIA. CP4 would help reduce estimated future water shortages by increasing the reliability of dry and critical year water supplies for agricultural and M&I deliveries by at least 47,300 acre-feet per year and average annual deliveries by about 31,000 acre-feet per year. CP4A would help reduce estimated future water shortages by increasing the reliability of dry and critical year water supplies for agricultural and M&I deliveries by at least 77,800 acre-feet per year and average annual deliveries by about 51,300 acre-feet per year. The majority of increased dry and critical year water supplies (42,700 acre-feet for CP4 and 67,100 acre-feet for CP4A) would be for south-of-Delta agricultural and M&I deliveries. In addition, water use efficiency could help reduce current and future water shortages by allowing a more effective use of existing supplies. As population and resulting water demands continued to grow and available supplies continued to remain relatively static, more effectively using these supplies could reduce potential critical impacts to agricultural and urban areas resulting from water shortages. Under CP4 and CP4A, approximately $1.6 million and $2.6 million, respectively, would be allocated over an initial 10-year period to fund agricultural and M&I water conservation programs, focused on agencies benefiting from increased reliability of project water supplies.

Develop Additional Hydropower Generation Higher water surface elevations in the reservoir would result in a net increase in power generation of about 127 GWh per year for CP4 and 125 GWh for CP4A. This generation value is the expected increased generation from Shasta Dam and other CVP/SWP facilities. Other power benefits for both CP4 and CP4A include additional capacity (i.e., the rate at which power can be generated) and ancillary services, which provide the ability to manage the electric grid in a reliable manner.

Conserve, Restore, and Enhance Ecosystem Resources In the upper Sacramento River, the addition of spawning gravel and the restoration of riparian, floodplain, and side channel habitat would be expected to improve the complexity of aquatic habitat and its suitability for anadromous salmonid spawning and rearing habitat. Riparian areas would provide habitat for a diverse array of plant and animal communities along the Sacramento River, including several threatened or endangered species. Riparian areas would also provide shade and woody debris that increase the complexity of aquatic habitat and its suitability for spawning and rearing. Lower floodplain areas, river terraces, and gravel bars would play an important role in the health and succession of riparian habitat. Restoration would support the goals of the Sacramento River Conservation Area Forum and other programs associated with riparian restoration along the Sacramento River. In addition, improved fisheries conditions as a result of cold-water carryover storage in CP4 or CP4A, as described above, and increased flexibility to meet flow and temperature requirements, could also enhance overall ecosystem resources in the Sacramento River. Side channels could support important habitat for anadromous salmonids, including rearing and spawning habitat. Side channel habitats would also provide refuge from predators and productive foraging habitat for juvenile anadromous salmonids.

Maintain and Increase Recreation Opportunities CP4 and CP4A include features to, at a minimum, maintain the existing recreation capacity at Shasta Lake. Potential recreation benefits would be as stated for CP3. Although neither CP4 nor CP4A include specific features to further increase recreation capacity, benefits to the water-oriented recreation experience at Shasta Lake would likely occur because of the increase in average lake surface area, reduced drawdown during the recreation season, and modernization of recreation facilities. For CP4, the maximum surface area of the lake would increase by about 2,600 acres (9 percent), from 29,700 acres to about 32,300 acres. The average surface area of the lake during the recreation season from May through September would increase by about 2,600 acres (11 percent), from 23,900 acres to 26,500 acres. For CP4A, the average surface area of the lake during the recreation season from May through September would increase by about 2,300 acres (10 percent), from 23,900 acres to 26,200 acres. .There would also be limited potential to provide additional benefits to recreation by allowing more reliable filling of the reservoir during the spring.

Benefits Related to Other Project Objectives CP4 and CP4A could also provide benefits related to flood damage reduction and water quality, similar to CP1 and CP2, respectively.

Construction for CP4 and CP4A

Construction activities for CP4 and CP4A would be identical to one another. Construction activities associated with physical features under CP4 or CP4A would include land-based construction activities associated with the following:

- Clearing vegetation from portions of the inundated reservoir area
- Constructing the dam raise, appurtenant structures, reservoir area dikes, and railroad embankments
- Relocating roadways, bridges, recreation facilities, utilities, and miscellaneous minor infrastructure
- Augmenting spawning gravel in the upper Sacramento River
- Restoring riparian, floodplain, and side channel habitat

Construction activities for CP4 and CP4A are described in Section 2.3.8, “Comprehensive Plan Construction Activities.”

Operations and Maintenance for CP4 and CP4A

Operations would differ between CP4 and CP4A, as described below. The anticipated maintenance for CP4 and CP4A would be identical to one another.

Operations for CP4 Operations under CP4 would be governed by the same regulatory constraints as described for CP1. Under CP4, the additional storage would be retained to increase water supply reliability and to expand the cold-water pool in Shasta Reservoir for fisheries benefits. Of the 634,000 acre-feet of additional storage, 378,000 acre-feet of water (60 percent) would be dedicated to increasing the cold-water supply for anadromous fish survival purposes. This would be in addition to any storage targets set by regulations described in Chapter 6, "Hydrology, Hydraulics, and Water Management." Similar to CP1, Shasta Dam operational guidelines would continue unchanged under CP4, except during dry and critical years, when 70,000 acre-feet and 35,000 acre-feet, respectively, of the increased storage capacity in Shasta Reservoir would be operated primarily to provide increased M&I deliveries. Operations targeting increased M&I deliveries were based on existing and anticipated future demands, operational priorities, and facilities of the SWP.

As modeled for CP4, the 378,000 acre-feet of additional water would be the first increment of the reservoir filled after the reservoir was enlarged. This amount of water would be available as additional water for the cold-water pool each year regardless of water year type, unless Reclamation elected to use the additional water to augment flows protecting anadromous fish in the Sacramento River, as part of a proposed adaptive management plan, as explained below. An additional 256,000 acre-feet of the increased storage space would be used primarily to improve water supply reliability; operations of Shasta Dam related to the 256,000 acre-feet of storage would be similar to operations under CP1.

As stated above, of the total 634,000 acre-feet of additional storage, 378,000 acre-feet of water would be used to increase the cold-water pool for fisheries. Reclamation is currently working with NMFS, USFWS, and CDFW through the Sacramento River Temperature Task Group (SRTTG), a multiagency group established to adaptively manage flows and water temperatures in the Sacramento River, to improve and stabilize Chinook salmon populations in the upper Sacramento River. The additional 378,000 acre-feet of cold-water pool would be managed by Reclamation in coordination with the SRTTG.

Current analysis indicates that the most beneficial use of the additional 378,000 acre-feet of storage for fisheries protection would be as an expanded cold-water pool; however, Reclamation has agreed to adaptively manage the 378,000 acre-feet of water, as appropriate, to increase benefits to anadromous fish as part of CP4. Adaptive management is an approach allowing decision makers to take advantage of a variety of strategies and techniques that are adjusted, refined, and/or modified based on an improved understanding of system dynamics.

Adaptive management, if applied appropriately, allows for flexible operations based on best available science and new information as it becomes available.

The adaptive management plan may include operational changes to the timing and magnitude of releases primarily to improve the quality and quantity of aquatic habitat. These changes may include increasing minimum flows, timing releases from Shasta Dam to mimic more natural seasonal flows, meeting flow targets for side channels, or retaining the additional 378,000 acre-feet of water in storage to meet temperature requirements. Reclamation would work cooperatively with the SRTTG to determine the best use of the cold-water pool each year under an adaptive management plan. Reclamation would manage the cold-water pool and operate Shasta Dam each year based on recommendations from the SRTTG. Because adaptive management would be predicated on using best available science and new information to make decisions, a monitoring program would be implemented as part of the adaptive management plan. SRTTG members would conduct monitoring, develop monitoring protocols, and set performance standards to determine the success of adaptive management actions.

Under the currently proposed operations, the 378,000 acre-feet of additional storage would be the first increment of water in the reservoir to fill after dam enlargement. This water would be available each year independent of water year type if used exclusively to enlarge the cold-water pool. If the 378,000 acre-feet of stored water were used to augment flows based on recommendations from the SRTTG, this water would not be guaranteed to be available for use the following year because of uncertainty in hydrologic conditions. Once water was released to augment flows as part of the adaptive management plan, the 378,000 acre-feet of additional storage space would be refilled after the 256,000 acre-feet of additional storage space was filled for the primary purpose of increasing water supply reliability. Each year that the 378,000 acre-feet of additional water was held in storage as part of an increase in the cold-water pool, the allocated amount would be available as long as the cold-water pool continued to provide benefits to fisheries.

SALMOD modeling and related analysis indicated that in most cases, providing an increased cold-water pool would benefit Chinook salmon populations in the Upper Sacramento River more than increasing flows. Therefore, the impacts and benefits of increasing flows under CP4 are not presented in this EIS. Per recommendations in Title 43, CFR Part 46, Section 46.145, substantive increases in flows associated with the adaptive management plan would be evaluated in subsequent NEPA analysis.

Operation of pumping facilities downstream from Shasta Dam would vary slightly from current operations and would result in higher costs. In addition, Reclamation would provide in-kind power to offset reduced generation at Pit 7 Dam and related facilities.

Operations for CP4A As modeled for CP4A, the 191,000 acre-feet of additional water would be the first increment of the reservoir filled after the reservoir was enlarged. This amount of water would be available as additional water for the cold-water pool each year regardless of water year type, unless Reclamation elected to use the additional water to augment flows protecting anadromous fish in the Sacramento River, as part of a proposed adaptive management plan, as explained below. An additional 443,000 acre-feet of the increased storage space would be used primarily to improve water supply reliability; operations of Shasta Dam related to the 443,000 acre-feet of storage would be similar to operations under CP2.

As stated above, of the total 634,000 acre-feet of additional storage, 191,000 acre-feet of water would be used to increase the cold-water pool for fisheries. Reclamation is currently working with NMFS, USFWS, and CDFW through the SRTTG, a multiagency group established to adaptively manage flows and water temperatures in the Sacramento River, to improve and stabilize Chinook salmon populations in the upper Sacramento River. The additional 191,000 acre-feet of cold-water pool would be managed by Reclamation in coordination with the SRTTG.

Current analysis indicated that the most beneficial use of the additional 191,000 acre-feet of storage for fisheries protection would be as an expanded cold-water pool; however, Reclamation has agreed to adaptively manage the 191,000 acre-feet of water, as appropriate, to increase benefits to anadromous fish as part of CP4A. Adaptive management is an approach allowing decision makers to take advantage of a variety of strategies and techniques that are adjusted, refined, and/or modified based on an improved understanding of system dynamics. Adaptive management, if applied appropriately, allows for flexible operations based on best available science and new information as it becomes available.

The adaptive management plan may include operational changes to the timing and magnitude of releases primarily to improve the quality and quantity of aquatic habitat. These changes may include increasing minimum flows, timing releases from Shasta Dam to mimic more natural seasonal flows, meeting flow targets for side channels, or retaining the additional 191,000 acre-feet of water in storage to meet temperature requirements. Reclamation would work cooperatively with the SRTTG to determine the best use of the cold-water pool each year under an adaptive management plan. Reclamation would manage the cold-water pool and operate Shasta Dam each year based on recommendations from the SRTTG. Because adaptive management would be predicated on using best available science and new information to make decisions, a monitoring program would be implemented as part of the adaptive management plan. SRTTG members would conduct monitoring, develop monitoring protocols, and set performance standards to determine the success of adaptive management actions.

Under the currently proposed operations, the 191,000 acre-feet of additional storage would be the first increment of water in the reservoir to fill after dam enlargement. This water would be available each year independent of water year type if used exclusively to enlarge the cold-water pool. If the 191,000 acre-feet of stored water was used to augment flows based on recommendations from the SRTTG, this water would not be guaranteed to be available for use the following year because of uncertainty in hydrologic conditions. Once water was released to augment flows as part of the adaptive management plan, the 191,000 acre-feet of additional storage space would be refilled after the 443,000 acre-feet of additional storage space was filled for the primary purpose of increasing water supply reliability. Each year that the 191,000 acre-feet of additional water was held in storage as part of an increase in the cold-water pool, the allocated amount would be available as long as the cold-water pool continued to provide benefits to fisheries.

SALMOD modeling and related analysis indicated that in most cases, providing an increased cold-water pool would benefit Chinook salmon populations in the Upper Sacramento River more than increasing flows. Therefore, the impacts and benefits of increasing flows under CP4A are not presented in this EIS. Per recommendations in Title 43, CFR Part 46, Section 46.145, substantive increases in flows associated with the adaptive management plan would be evaluated in subsequent NEPA analysis.

Operation of pumping facilities downstream from Shasta Dam would vary slightly from current operations and would result in higher costs. In addition, Reclamation would provide in-kind power to offset reduced generation at Pit 7 Dam and related facilities.

Maintenance for CP4 and CP4A Maintenance of facilities related to the proposed dam and reservoir enlargement would be similar to maintenance activities currently conducted at Shasta Dam and Reservoir.

2.3.7 CP5 – 18.5-Foot Dam Raise, Combination Plan

CP5 primarily focuses on increased water supply reliability, anadromous fish survival, Shasta Lake area and upper Sacramento River environmental resources, and increased recreation opportunities.

Major Components of CP5

CP5 includes the following major components:

- Raising Shasta Dam and appurtenant facilities by 18.5 feet
- Constructing additional resident fish habitat in Shasta Lake and along the lower reaches of its tributaries (Sacramento River, McCloud River, and Squaw Creek)
- Constructing shoreline fish habitat around Shasta Lake

- Augmenting spawning gravel in the upper Sacramento River
- Restoring riparian, floodplain, and side channel habitat in the upper Sacramento River
- Increasing recreation opportunities at Shasta Lake
- Implementing the set of eight common management measures previously described
- Implementing the common environmental commitments previously described

By raising Shasta Dam 18.5 feet, from a crest elevation of 1,077.5 feet to 1,096.0 feet (based on NGVD29), CP5 would increase the height of the reservoir full pool by 20.5 feet. The additional 2-foot increase in the height of the full pool above the dam raise height would result from spillway modifications similar to the modifications proposed under CP1. This increase in full pool height would add approximately 634,000 acre-feet of storage to the reservoir's capacity. Accordingly, storage in the overall full pool would be increased from 4.55 MAF to 5.19 MAF. Table 2-6 summarizes major physical features associated with CP5.

Under CP5, the additional storage in Shasta Reservoir would be used to increase water supply reliability and to expand the cold-water pool for downstream anadromous fisheries. The existing TCD would be extended to achieve efficient use of the expanded cold-water pool. Operations for water supply, hydropower, and environmental and other regulatory requirements would be similar to existing operations, except during dry and critical years when a portion of the increased storage in Shasta Reservoir would be reserved to specifically focus on increasing M&I deliveries. In dry years, 150,000 acre-feet of the 634,000 acre-feet increased storage capacity in Shasta Reservoir would be reserved for increasing M&I deliveries. In critical years, 75,000 acre-feet of the increased storage capacity would be reserved for increasing M&I deliveries.

As described for the above alternatives, this alternative also would include the potential to revise the flood control operational rules for Shasta Dam and Reservoir, which could reduce the potential for flood damage and benefit recreation.

CP5 also involves (1) restoring resident fish habitat in Shasta Lake; (2) restoring fisheries and riparian habitat at several locations along the lower reaches of the tributaries to Shasta Lake; (3) augmenting spawning gravel in the upper Sacramento River; (4) restoring riparian, floodplain, and side channel habitat in the upper Sacramento River; and (5) increasing recreation opportunities at Shasta Lake.

Construct Reservoir Shoreline Enhancement The ecosystem enhancement goal for the shoreline environment of Shasta Lake is to improve warm-water fish habitat associated with the transition between the reservoir's aquatic and terrestrial habitats. Shoreline enhancement entails a range of enhancement opportunities along the Shasta Lake shoreline below the full pool elevation of 1,090 feet (based on the North American Vertical Datum of 1988 (NAVD88))[3] that would occur with an 18.5-foot dam raise. This area is typically between 0.1 mile and 1.5 miles upslope from the current full pool elevation of 1,070 feet (based on NAVD88). The shoreline is defined as the area encompassing nearshore aquatic habitat within the reservoir itself and vegetation and other habitat components adjacent to the reservoir.

Two categories of potential nearshore warm-water fish habitat enhancement activities would be (1) structural enhancements, which entail placing artificial structures in the Shasta Lake littoral zone; and (2) vegetative enhancements, which entail planting and seeding to provide submerged and partly submerged vegetative cover when the reservoir is at full pool capacity during the winter/spring months.

Construction activities common to all action alternatives would include stockpiling manzanita for fish habitat (see Section 2.3.2, "Environmental Commitments Common to All Action Alternatives"). CP5 would involve clearing additional manzanita from above the new full pool inundation zone to create further structural enhancements for fish habitat in the Shasta Lake littoral zone.

Vegetative enhancements associated with CP5 would include planting willows (*Salix*) to enhance nearshore fish habitat, and single-treatment aerial and hand seeding of annual native grasses to treat shoreline areas at Shasta Lake. Treatment with native grasses would provide only short-term cover, but would be cost-effective across large areas and can be implemented quickly and efficiently. The annual native grasses would provide cover for young fish and also nutrients for plankton as the grasses decompose. The plankton in turn would be a valuable food source for juvenile fish.

Construct Reservoir Tributary Aquatic Habitat Enhancement The primary goal for the enhancement of aquatic habitat in the watershed is to improve the connectivity for native fish species and other aquatic organisms between Shasta Lake and its tributaries. Two categories of potential aquatic habitat enhancement in tributaries would be (1) fish passage enhancements, which entail identifying and correcting barriers to fish passage, particularly at culverts and other human-made barriers; and (2) aquatic habitat enhancements, which entail identifying and implementing feasible habitat improvements

[3] Shasta Lake water surface elevations are based on NAVD88. All current feasibility-level designs and figures for reservoir area infrastructure modifications and relocations to accommodate increased water levels are based on a 2001 aerial survey of the reservoir which was completed using NAVD88.

intended to conserve or restore degraded aquatic and riparian habitat in tributaries to Shasta Lake.

Fish passage enhancements associated with CP5 would include opportunities to restore and/or enhance five perennial stream crossings. Barriers to fish passage in the watersheds above Shasta Lake would be associated primarily with culverts or other types of stream crossings.

Aquatic habitat enhancements associated with CP5 would involve enhancing aquatic connectivity and reducing sediment related to roads constructed across intermittent streams. The preliminary site survey identified opportunities to enhance 14 intermittent stream crossings. Based on the information obtained in the survey, these crossings would provide opportunities for meeting the objectives of enhancing aquatic connectivity and/or reducing the potential for road-related sediment. Two sites have been identified in the Salt Creek watershed, two sites have been identified in the Sugarloaf Creek watershed, and 10 sites have been identified in the McCloud River Arm watershed.

Augment Spawning Gravel in Upper Sacramento River As described in CP4 and CP4A, spawning gravel would be added to the upper Sacramento River. This measure would be identical to that proposed under CP4 and CP4A.

Restore Riparian, Floodplain, and Side Channel Habitat As described in CP4 and CP4A, riparian, floodplain, and side channel habitat restoration would occur at suitable locations along the Sacramento River. This measure would be identical to that proposed under CP4 and CP4A.

Recreation Enhancements A total of 18 miles of new hiking trails and 6 trailheads would be constructed to enhance recreation under CP5.

Potential Benefits of CP5

Major potential benefits of CP5, related to the project objectives, are described below.

Increase Anadromous Fish Survival Water temperature is one of the most important factors affecting anadromous fish survival in the Sacramento River. CP5 would increase the ability of Shasta Dam to make cold-water releases and regulate water temperature in the upper Sacramento River, primarily in dry and critical water years. This would be accomplished by raising Shasta Dam 18.5 feet, thus increasing the depth of the cold-water pool in Shasta Reservoir and resulting in an increase in seasonal cold-water volume below the thermocline (layer of greatest water temperature and density change). Cold water released from Shasta Dam significantly influences water temperature conditions in the Sacramento River between Keswick Dam and the RBPP. Hence, the most significant water temperature benefits to anadromous fish would occur upstream from the RBPP. It is estimated that improved water temperature and flow conditions under CP5 could result in an annual average increase in the Chinook salmon population of about 377,800 out-migrating juvenile fish.

Increase Water Supply Reliability CP5 would increase water supply reliability by increasing water supplies for CVP and SWP irrigation and M&I deliveries. This action would contribute to replacement of supplies redirected to other purposes in the CVPIA. CP5 would help reduce estimated future water shortages by increasing the reliability of dry and critical year water supplies for agricultural and M&I deliveries by at least 113,500 acre-feet per year, and average annual deliveries by about 75,900 acre-feet per year. The majority of increased dry and critical year water supplies (88,300 acre-feet) would be for south-of-Delta agricultural and M&I deliveries. In addition, increased water use efficiency could help reduce current and future water shortages by allowing a more effective use of existing supplies. As population and resulting water demands continued to grow and available supplies continued to remain relatively static, more effective use of these supplies could reduce potential critical impacts to agricultural and urban areas resulting from water shortages. Under CP5, approximately $3.8 million would be allocated over an initial 10-year period to fund agricultural and M&I water conservation programs, focused on agencies benefiting from increased reliability of project water supplies.

Develop Additional Hydropower Generation Higher water surface elevations in the reservoir would result in a net increase in power generation of about 112 GWh per year. This generation value is the expected increased generation from Shasta Dam and other CVP/SWP facilities. Other power benefits include additional capacity (i.e., the rate at which power can be generated) and ancillary services, which provide the ability to manage the electric grid in a reliable manner.

Conserve, Restore, and Enhance Ecosystem Resources CP5 would provide for habitat improvements both in the reservoir area and downstream from Shasta Dam on the upper Sacramento River.

Along the Shasta Lake shoreline, shallow warm-water fish habitat would be improved by using manzanita cleared from above the inundation zone to create structural enhancements, planting willows to enhance nearshore fish habitat, and seeding of native grasses to treat shoreline areas. Once established, the willows and native grasses would provide submerged and partly submerged vegetative cover when the reservoir is at full pool during the winter/spring months. These improvements would help provide favorable spawning conditions, and juvenile fish leaving the tributaries would benefit from improved adjacent shoreline habitat. Placing manzanita brush structures near the shoreline would enhance the diversity of structural habitat available for the warm-water fish species that occupy Shasta Lake. Establishing vegetation also could benefit terrestrial species that inhabit the shoreline of Shasta Lake.

The lower reaches of perennial tributaries to Shasta Lake would be the focus for aquatic restoration under CP5 because they provide year-round fish habitat. Native fish species require connectivity to the full range of habitats offered by Shasta Lake and its tributaries. Improved fish passage would address the requirement to provide access and/or modify barriers to improve ecological conditions that support these native fish assemblages. Aquatic habitat improvements would include enhancing aquatic connectivity and reducing sediment related to roads constructed across intermittent streams.

In the upper Sacramento River, the addition of spawning gravel and the restoration of riparian, floodplain, and side channel habitat would be expected to improve the complexity of aquatic habitat and its suitability for spawning and rearing. Riparian areas would provide habitat for a diverse array of plant and animal communities along the Sacramento River, including numerous threatened or endangered species. Riparian areas would also provide shade and woody debris that increase the complexity of aquatic habitat and its suitability for spawning and rearing. Lower floodplain areas, river terraces, and gravel bars would play an important role in the health and succession of riparian habitat. Restoration would support the goals of the Sacramento River Conservation Area Forum and other programs associated with riparian restoration along the Sacramento River. Side channels could support important habitat for anadromous salmonids, including rearing and spawning habitat. Side channel habitats would also provide refuge from predators and productive foraging habitat for juvenile anadromous salmonids.

Maintain and Increase Recreation Opportunities CP5 includes features to, at a minimum, maintain the existing recreation capacity at Shasta Lake. In addition, this alternative involves construction of 18 miles of new trails and 6 trailheads to enhance recreation opportunities at Shasta Lake. As with the other alternatives, benefits to the water-oriented recreation experience at Shasta Lake would likely occur because of the increase in average lake surface area, reduced drawdown during the recreation season, and modernization of recreation facilities. The maximum surface area of the lake would increase by about 2,600 acres (9 percent), from 29,700 acres to about 32,300 acres. The average surface area of the lake during the recreation season from May through September would increase by about 1,900 acres (8 percent), from 23,900 acres to 25,800 acres. There would also be limited potential for reservoir reoperation to provide additional benefits to recreation by allowing more reliable filling of the reservoir during the spring.

Benefits Related to Other Project Objectives CP5 could also provide benefits related to flood damage reduction and water quality, similar to CP3.

Construction for CP5

Construction activities associated with physical features under CP5 would include land-based construction activities associated with the following:

- Clearing vegetation from portions of the inundated reservoir area
- Constructing the dam raise, appurtenant structures, reservoir area dikes, and railroad embankments
- Relocating roadways, bridges, recreation facilities, utilities, and miscellaneous minor infrastructure
- Augmenting spawning gravel in the upper Sacramento River
- Restoring riparian, floodplain, and side channel habitat
- Enhancing Shasta Lake and tributary shoreline

Construction activities for CP5 are described in Section 2.3.8, "Comprehensive Plan Construction Activities."

Operations and Maintenance for CP5

Operations under CP5 would be governed by the same regulatory constraints as described for CP1. Similar to CP1, the additional storage would be retained to increase water supply reliability and to expand the cold-water pool in Shasta Reservoir for fisheries benefits. Similar to CP1, Shasta Dam operational guidelines would continue unchanged, except during dry and critical years, when 150,000 acre-feet and 75,000 acre-feet, respectively, of the 634,000 acre-feet increased storage capacity in Shasta Reservoir would be operated primarily to provide increased M&I deliveries. Operations targeting increased M&I deliveries were based on existing and anticipated future demands, operational priorities, and facilities of the SWP. For CP5, existing water quality and temperature requirements would typically be met in most years; therefore, additional water in storage would be released primarily for water supply purposes. Accordingly, minimal increases in flow would be expected in months when Delta exports were constrained, or when flow was not usable for water supply purposes.

In comparison to current operations, CP5 would store some additional flows behind Shasta Dam during periods when downstream needs would have already been met, but flows would have been released because of storage limitations. The resulting increase in storage would be released downstream when there were opportunities for beneficial use of the water, either to meet water supply reliability demands or to improve Reclamation's abilities to meet its environmental objectives. The additional water in storage would also expand the cold-water pool and increase end-of-September carryover storage in Shasta

Reservoir, increasing the ability of Shasta Dam to improve water temperatures for anadromous fish in the upper Sacramento River.

Conversely, if water in storage were insufficient to meet all of the project purposes, the first increment to be reduced would be deliveries to water service contractors. Releases from Shasta Dam under CP5 would typically increase in the summer months, corresponding with the periods of greatest agricultural demands. Similarly, releases would be reduced in the winter months, when the increased storage space could be used to capture additional runoff rather than releasing water to the downstream river, as would occur with Shasta Reservoir's current operations.

Maintenance of facilities related to the proposed dam and reservoir enlargement would be similar to maintenance activities currently conducted at Shasta Dam and Reservoir.

Operation of pumping facilities downstream from Shasta Dam would vary slightly from current operations and would result in higher costs. In addition Reclamation would provide in-kind power, to offset the reduced generation at Pit 7 Dam and related facilities

2.3.8 Comprehensive Plan Construction Activities

Construction activities under all comprehensive plans would include land-based construction activities associated with the following:

- Clearing vegetation from portions of the inundated reservoir area
- Constructing the dam raise, appurtenant structures, reservoir area dikes, and railroad embankments
- Relocating roadways, bridges, recreation facilities, utilities, and miscellaneous minor infrastructure

CP4, CP4A, and CP5 would also include construction activities associated with gravel augmentation and restoring riparian, floodplain, and side channel habitat. Additional construction activities associated with Shasta Lake and tributary shoreline enhancements are included under CP5. Construction activities under the proposed action alternatives are described below. For additional considerations, please refer to the Engineering Summary Appendix.

Clearing Portions of Inundated Reservoir Area

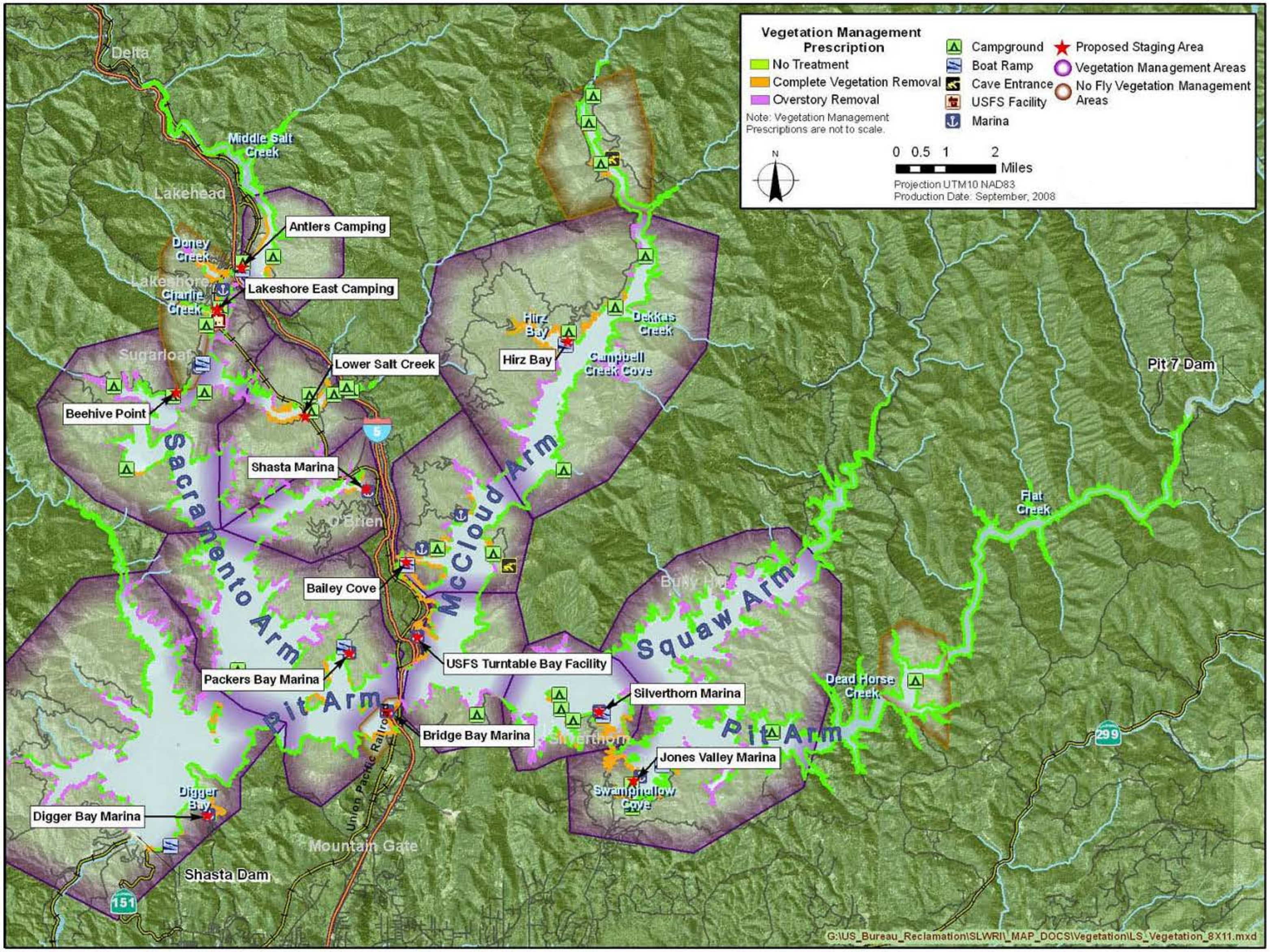
A portion of the acreage inundated at the new reservoir full pool would need to be cleared. This would involve removing trees and other vegetation from around the reservoir shoreline at select areas. Willows, cottonwoods, and buttonbush would not be removed in and along riparian areas. Manzanita removed in cleared areas would be stockpiled and used for fish habitat structures placed in designated locations. Structures, utilities, and other infrastructure would also need to be removed and/or relocated, as described below in more detail.

Fifteen vegetation management areas have been delineated to facilitate efficient removal of vegetation around the reservoir perimeter, including 11 areas of complete vegetation removal and 4 areas of overstory removal (see Figure 2-5). The acreages of each vegetation management area affected by identified reservoir clearing treatments are summarized in Table 2-7 below.

Vegetation management activities would need to be complete before inundation of new areas created by enlarging the reservoir. A single staging area (landing) would serve each vegetation management area. Access for vegetation removal activities would most likely be limited to late summer and fall, when water levels are low and recreation use has decreased. Removal by helicopter would generally be limited to spring and fall because of the limited availability of helicopters during the summer fire season. Vegetation removal would also be limited during bird nesting season, typically early spring through mid-summer. Breeding bird surveys in suitable habitats would be performed to determine the appropriate time frame for vegetation removal activities. Because of distance and/or safety constraints, helicopters would not be used in the following vegetation management areas: Bridge Bay, Lakeshore East, Pit Arm, and McCloud Arm. Slash burning could take place during the winter seasons following vegetation treatment and would comply with all regulations set forth by the Shasta County Air Quality Management District. Methods for clearing the reservoir area are summarized below.

Complete Vegetation Removal Complete vegetation removal would clear all existing vegetation from the designated treatment area and would generally be applied to locations along and adjacent to developed recreation areas, including boat ramps, day use areas, campgrounds, marinas, and resorts. Exceptions would be made in areas with high shoreline erosion potential, or habitat for special-status species.

Timber would be harvested and removed to landings by ground-skidding equipment if road access is available and slopes are less than 35 percent; otherwise, trees would be yarded by helicopter and residual vegetation and activity-created slash would be piled and burned by hand. Where possible, trees would be felled into the reservoir during removal to minimize damage to reservoir embankments. Tree stumps would be cut to within 24 inches of the ground surface and brush stumps would be cut flush to the ground. Stumps would be left in place to reduce shoreline erosion. Complete vegetation removal is intended to maximize shoreline access and minimize the risk to visitors from snags and water hazards.



Key: USFS = U.S. Department of Agriculture, Forest Service

Figure 2-5. Vegetation Management Areas

Table 2-7. Reservoir Clearing Treatment Applied By Action Alternative

Landing Location	CP1				CP2				CP3, CP4, CP4A, and CP5			
	Complete Removal (acres)	Complete Removal Quantity (board feet)	Overstory Removal (acres)	Overstory Removal Quantity (board feet)	Complete Removal (acres)	Complete Removal Quantity (board feet)	Overstory Removal (acres)	Overstory Removal Quantity (board feet)	Complete Removal (acres)	Complete Removal Quantity (board feet)	Overstory Removal (acres)	Overstory Removal Quantity (board feet)
Antlers	8	48,600	5	33,400	12	76,600	8	52,700	17	109,300	12	75,100
Bailey Cove	17	148,400	7	40,600	26	234,000	11	64,000	37	333,700	15	91,300
Beehive Point	3	5,400	24	102,300	4	8,500	38	161,300	6	12,100	54	230,100
Bridge Bay	9	51,800	0	0	14	81,600	0	0	20	116,400	0	0
Digger Bay	8	27,700	31	92,600	13	43,700	49	146,000	19	62,400	70	208,300
Hirz Bay	22	211,200	22	169,500	35	333,000	34	267,300	49	474,900	49	381,200
Jones Valley	17	81,700	51	328,000	26	128,800	81	517,100	38	183,700	116	737,500
Lakeshore East	17	58,800	2	12,500	27	92,800	4	19,700	39	132,300	5	28,100
Lower Salt Creek	14	96,300	15	62,700	22	151,800	24	98,900	31	216,500	35	141,100
McCloud Arm	4	14,900	0	0	7	23,500	0	0	10	33,500	0	0
Packers Bay	7	29,200	22	78,800	11	46,000	35	124,200	16	65,600	50	177,100
Pit Arm	2	22,400	0	0	3	35,300	0	0	4	50,400	0	0
Shasta Marina	1	17,900	13	89,400	2	28,200	21	141,000	2	40,200	30	201,100
Silverthorn	17	117,900	18	115,100	26	185,900	29	181,400	37	265,200	41	258,800
Turntable	5	33,100	8	88,700	8	52,200	13	139,900	11	74,400	19	199,500
Total	**150**	**965,300**	**220**	**1,213,600**	**236**	**1,521,900**	**347**	**1,913,500**	**337**	**2,170,600**	**495**	**2,729,200**

Key:
CP = comprehensive plan

Overstory Removal Overstory removal involves removing all trees from the treatment area that are greater than 10 inches in diameter at breast height, or 15 feet in height, generally in houseboat mooring areas or narrow arms of the reservoir where snags pose the greatest risk to boaters. Trees would be harvested and removed to landings by ground-skidding equipment if road access is available and slopes are less than 35 percent; otherwise, trees would be yarded by helicopter and activity-created slash would be piled and burned by hand. The remaining understory vegetation would be left in place. As for complete vegetation removal, where possible, trees would be felled into the reservoir during removal to minimize damage to reservoir embankments. Tree stumps would be cut to within 24 inches of the ground surface. Stumps would be left in place to reduce shoreline erosion. Overstory removal is intended to minimize the risk to visitors from snags and water hazards.

No Treatment Designated areas of the inundation zone would be left untreated with no vegetation removed. This prescription would generally be applied to stream inlets, the upper end of major drainages, the shoreline of wider arms of the reservoir, and special habitat areas. This treatment is intended to maximize the habitat benefits of inundated and residual vegetation.

Construction of Dam and Appurtenant Structures

This section summarizes major features associated with enlarging Shasta Dam and Reservoir and modifying its appurtenances (i.e., spillway and outlet works) for all comprehensive plans (action alternatives). Total surface area that would be required for work limits and permanent features, and an estimate of materials needed to modify Shasta Dam and its appurtenances under each comprehensive plan are shown in Table 2-8. For more detailed explanations of design considerations, please refer to the Engineering Summary Appendix.

Table 2-8. Physical Features for Proposed Modifications of Shasta Dam and Appurtenances for Action Alternatives

Physical Features	CP1	CP2	CP3, CP4, CP4A, and CP5
Quantity of Concrete (cubic yards)	57,000	77,300	100,800
Quantity of Cement (tons)	128,600	170,500	213,000
Quantity of Metalwork (pounds)	19,654,400	20,435,900	21,751,200
Volume of Imported Fill Material (cubic yards)	61,200	94,400	130,500
Volume of Excavation to Waste Material (cubic yards)	1,600	1,600	1,600
Quantity of Demolished Material (cubic yards)	25,400	29,200	31,600
Area of Permanent Structures (square feet)	412,600	412,600	412,600
Area of Work Limits (square feet)	460,900	460,900	460,900

Key:
CP = comprehensive plan

Dam Crest Structure Removal Before enlargement of Shasta Dam, existing structures on the dam crest would need to be removed. These structures include the gantry crane, existing spillway drum gates and frames, the spillway bridge, concrete in the spillway crest and abutments, upstream parapet walls, sidewalks, curbing, crane rails, and control equipment. This preparatory work would be similar for all comprehensive plans.

Modifying the main dam would require the demolition, removal, and transportation of top-of-dam materials to an approved disposal area. This would include the demolition and removal of the upstream reinforced-concrete parapet wall and curb. Sawcuts would be used to aid in removing the upstream reinforced-concrete parapet wall and curb. In addition, sawcuts would be required along the upstream face and crest of the dam to embed a polyvinyl chloride waterstop. The existing dam crest would be prepared by using a high-pressure water jet on the concrete surface to facilitate bonding with the new concrete to be placed. Existing roadway drains would be backfilled with cement grout.

Drain holes would be drilled from two different locations: from the existing dam crest to drain the surface contact and from the existing dam crest for surface drainage at the downstream overhang. A vertical shaft would be excavated through the concrete from the existing dam crest to the hoist gallery to install electrical conduit.

The existing spillway drum gates and piers would require removal according to a phased construction plan that would minimize impacts to reservoir operations during construction. Two drum gates and one pier would be removed to construct three new piers and install three new sloping fixed-wheel gates. This would be followed by removal of the remaining drum gate and pier to construct two new piers and install three new sloping fixed-wheel gates.

The spillway bridge and dam crest access road would be out of service for an extended period of time (over two years) during construction of the new spillway and dam crest raise. A detour route would be provided below the dam across an existing bridge. Modifications to the TCD would be performed to minimize impacts to reservoir operations to the extent possible, but supplemental cold water releases may be required through the river outlets during a portion of the construction period. Control equipment for the TCD would be removed, stored, and reinstalled for the higher dam crest. The elevator tower would be out of service for about 4 months for construction of the dam crest raise and for replacement of the elevator car and hoist equipment.

Main Gravity Dam and Wing Dams Enlargement of Shasta Dam under all action alternatives would require raising Shasta Dam (the main gravity dam) and its left and right wing dams as indicated in Table 2-9. Construction activities to raise the main gravity dam and the left and right wing dams are summarized below.

Table 2-9. Physical Features for Proposed Modifications of Shasta Dam and Appurtenances for Action Alternatives

Feature	Existing	CP1	CP2	CP3, CP4, CP4A, CP5
Main Gravity Dam				
Crest Raise (feet)	0	6.5	12.5	18.5
Crest Elevation[1]	1077.5	1,084.0	1,090.0	1,096.0
Upstream Parapet Wall Elevation[1]	1079.1	1,087.5	1,093.5	1,099.5
Full Pool Elevation[2]	1069.7	1,078.2	1,084.2	1,090.2
Left Wing Dam				
Crest Raise (feet)	0	8.5	14.5	20.5
Crest Elevation[1]	1077.5	1,086.0	1,092.0	1,098.0
Upstream Parapet Wall Elevation[1]	1079.1	1,089.5	1,095.5	1,101.5
Right Wing Dam				
Crest Raise (feet)	0	6.5	12.5	18.5
Crest Elevation[1]	1077.5	1,084.0	1,090.0	1,096.0
Upstream Parapet Wall Elevation[1]	1079.1	1,087.5	1,093.5	1,099.5
Spillway				
Crest Raise (feet)	0	0.5	6.5	12.5
Crest Elevation[1]	1037.0	1,037.5	1,043.5	1,049.5

Notes:
[1] Main dam and wing dam crest elevations are based on the National Geodetic Vertical Datum of 1929 (NGVD29). All current feasibility-level designs and figures for Shasta Dam and appurtenant structures are based on NGVD29.
[2] Full pool elevations are based on the North American Vertical Datum of 1988 (NAVD88), which is 2.66 feet higher than NGVD29. All current feasibility-level designs and figures for reservoir area infrastructure modifications and relocations to accommodate increased water levels are based on a 2001 aerial survey of the reservoir using NAVD88.
Key:
CP = comprehensive plan

Shasta Dam would be raised by placing mass concrete corresponding in width to the existing dam monolith blocks on the existing dam crest (concrete gravity section and spillway crest section). Structural concrete would be placed for the top of the dam, including for the roadway, the upstream and downstream parapets, and the walkway. Reinforcing steel would be used around the utility gallery, and nominal temperature steel would be used for the exposed structural concrete surfaces. Steel top-of-dam drains would be furnished and installed in each block to drain to the upstream face. Surface area and features of the new dam crest would be similar to the existing dam crest, including gantry crane rails and surface drains. A new upstream parapet wall would provide additional flood protection. The dam raise would include a new utility gallery.

Zoned embankment wing dams were originally constructed on both abutments of the main dam to protect the contact between the concrete and the excavated foundation surface. The left wing dam would be raised to maintain the same height above the top of joint-use storage, as for existing conditions. This would involve extending the existing reinforced-concrete core wall to the raised dam crest, and placing a thick layer of large rockfill downstream from the core wall. The upstream face would consist of a reinforced concrete or mechanically stabilized earth wall, and a concrete parapet wall. The road from the concrete dam crest would be ramped up through the left wing dam to the new embankment crest. Roadways and security features on the existing dam crest would be relocated to the new dam crest. The existing rotunda on the left abutment of the dam would be removed and reconstructed.

A building housing a visitor center and Reclamation offices, a parking lot, picnic areas, and vista points have been incorporated into the left abutment design. The visitor center building would provide adequate space for visitors, storage, staff, and security functions, and feature a panoramic view of all facilities. The existing roadways, lawns, sidewalks, trees, and other features on the left wing dam crest would be restored to a configuration similar to existing conditions. Existing facilities would be removed from the site before construction, and replaced after the raise is completed.

The right wing dam would be raised to match the main gravity dam crest. Concrete was selected for the right wing dam in lieu of embankment to facilitate construction. The new right wing dam crest would provide surface area and features similar to the existing dam crest, including gantry crane rails and surface drains. A new upstream parapet wall would provide additional flood protection. The right wing dam would include a new utility gallery and a foundation drainage curtain. Right abutment access roads would be modified to match the new dam crest.

Spillway Structural concrete would be used to raise the existing spillway crest and to shape the raised spillway crest as indicated in Table 2-9. The existing spillway bridge, two existing spillway piers, cantilever wall sections, and three existing drum gates and operating equipment would be removed. Five new spillway piers would be constructed at locations within the spillway, designed to avoid existing overflow block contraction joints, and a new concrete spillway crest would be constructed between them. The locations of the new piers would result in different widths of spillway gates. The three existing 110-foot by 28-foot drum gates would be replaced with six sloping, fixed-wheel gates. The total spillway crest length would be reduced from 330 feet to 300 feet as a result. A new bridge would be required over the spillway to allow for vehicular traffic and for a gantry crane to travel from one end of the dam to the other.

Temperature Control Device Modifications to the TCD would be needed for all action alternatives. Modifications would primarily involve extending the main steel structure to the new full pool elevation; raising the TCD operating equipment, including gate hoists, electrical equipment, miscellaneous metalwork, and hoist platform above the new top of joint-use elevation; installation of additional cladding on the existing and raised sections of the TCD; and lengthening/replacing shutter operating cables.

Shasta Powerplant Penstock Intake and Penstock Modifications The centerline of the existing penstock intakes would remain at the current level, but the gate hoists would require relocation with a higher dam crest. The existing steel penstock pipes have been determined to be adequate for the higher reservoir loads and no penstock modifications are anticipated.

Pit 7 Facilities The Pit 7 Dam and Powerhouse, which is owned and operated by Pacific Gas and Electric Company (PG&E), is located on the upper Pit River at the northeast end of Shasta Lake. The complex consists of three main features: a main dam with integral spillway, a two-unit hydroelectric powerhouse immediately downstream from the main dam, and an afterbay dam. The expected modifications to the Pit 7 facilities associated with any action alternative include main dam spillway, powerhouse, and afterbay dam modifications.

Pit 7 Dam spillway backwater conditions have the possibility of creating wave action that could undermine the powerhouse and dam when flows are released over the spillway. It is recommended that both the left and right concrete training walls be increased in height to prevent this from occurring.

For Pit 7 Powerhouse, new sump pumps and a tailwater depression system are recommended. To ensure that proper operation of equipment in the powerhouse, the dewatering capacity of the existing sump pumps will need to be increased to address any additional seepage. This can be achieved with the installation of a new submersible pump. A tailwater depression system will need to be installed. During high flows, a tailwater depression system would introduce compressed air into the turbine runner pit to depress the tailwater to a level that does not interfere with turbine operation, thereby allowing continued turbine operation. The tailwater depression system would include air compressors, air discharge piping with control valves, water-level sensors, power supply, and electrical controls. Air compressors would be of the high-volume, low-pressure type, referred to as "blowers." Blowers would be driven by electric motors supplied with available power from the Pit 7 Powerhouse.

The Pit 7 Afterbay Dam may require the placement of rock dowels and rip rap for slope stability to meet the necessary safety standards. Ancillary facilities will need to be addressed near the Pit 7 Afterbay Dam including relocating the gaging station and cableway that would be inundated by the new high water line, extending the boat barriers, relocating security fences and signs, rehabbing the existing boat ramp, and relocating the warning siren.

Reservoir Area Dikes and Railroad Embankments

The physical features for the proposed dikes and railroad embankments under each comprehensive plan are shown in Table 2-10. The proposed dikes would be constructed using common earthmoving equipment and methods. Additional excavation to provide working surfaces and keys for the embankment fill would be required along the slope of the upstream foundation for some of the proposed dikes. Ground treatment and/or over-excavation may be necessary in some areas to remove and/or treat pervious material. Riprap would be placed on the upstream face of each dike to the crest of the dike to protect against wave run-up and erosion. Reservoir area dikes and railroad embankments are further described in the Engineering Summary Appendix.

Table 2-10. Physical Features for Proposed Dikes and Railroad Embankments by Action Alternative

Dike Features	CP1	CP2	CP3, CP4, CP4A, and CP5
Lakeshore Dikes/Railroad Embankments			
Doney Creek Dike			
Volume of Fill Material (core, drain, filter) (cubic yards)	-	12,200	75,000
Volume of Riprap (cubic yards)	-	1,000	5,900
Volume of Excavated Material (cubic yards)	-	3,100	10,200
Site Clearing and Grubbing Below Dike (acres)	-	1.5	7.2
Antlers Dike			
Volume of Fill Material (core, drain, filter) (cubic yards)	-	-	4,900
Volume of Riprap (cubic yards)	-	-	400
Volume of Excavated Material (cubic yards)	-	-	300
Site Clearing and Grubbing Below Dike (acres)	-	-	0.9
North Railroad Embankment			
Volume of Fill Material (core, filter) (cubic yards)	17,100	17,100	17,100
Volume of Riprap (cubic yards)	400	400	400
Volume of Excavated Material (cubic yards)	1,500	1,500	1,500
Site Clearing and Grubbing Below Dike (acres)	1.2	1.2	1.2
Middle Railroad Embankment			
Volume of Fill Material (core, filter) (cubic yards)	13,400	13,400	13,400
Volume of Riprap (cubic yards)	300	300	300
Volume of Excavated Material (cubic yards)	4,000	4,000	4,000
Site Clearing and Grubbing Below Dike (acres)	2.9	2.9	2.9
South Railroad Embankment			
Volume of Fill Material (core, filter) (cubic yards)	101,900	101,900	101,900
Volume of Riprap (cubic yards)	2,500	2,500	2,500
Volume of Excavated Material (cubic yards)	8,500	8,500	8,500
Site Clearing and Grubbing Below Dike (acres)	6.2	6.2	6.2
Bridge Bay Dikes			
West Dike			
Volume of Fill Material (core, drain, filter) (cubic yards)	3,000	7,700	69,000
Volume of Riprap (cubic yards)	200	800	23,600
Volume of Excavated Material (cubic yards)	2,100	5,000	15,300
Site Clearing and Grubbing Below Dike (acres)	0.8	1.4	2.2
East Dike			
Volume of Fill Material (core, drain, filter) (cubic yards)	1,000	3,000	40,100
Volume of Riprap (cubic yards)	40	160	7,400
Volume of Excavated Material (cubic yards)	900	2,000	16,900
Site Clearing and Grubbing Below Dike (acres)	0.4	0.6	1.1

Key:
- = not applicable
CP = comprehensive plan

Relocations

As a result of the proposed Shasta Dam raise under the comprehensive plans, the following major features would be inundated by the increase in full pool elevation:

- Roadways
- Vehicle bridges
- Railroad bridges
- Recreation facilities
- Utilities and miscellaneous minor infrastructure

Existing infrastructure affected by enlarging Shasta Dam and Reservoir under any of the comprehensive plans would need to be removed and/or relocated.

Roadways Physical features associated with proposed road relocations under each comprehensive plan are shown by major focus area in Table 2-11. Road design criteria and construction characteristics are discussed in detail in the Engineering Summary Appendix.

Table 2-11. Physical Features for Proposed Road Relocations by Major Road Focus Area for Action Alternatives

Road Relocation Features	CP1	CP2	CP3, CP4, CP4A, and CP5
Lakeshore Drive			
Number of Road Segments Affected	4	6	8
Length (linear feet)	8,100	13,100	13,700
Clearing and Grubbing (acres)	4	7	7
Excavation to Embankment (cubic yards)	46,100	55,100	55,500
Embankment Fill (cubic yards)	122,800	171,800	174,900
Closure Expected	No	No	No
Turntable Bay Area			
Number of Road Segments Affected	3	3	3
Length (linear feet)	6,200	6,200	6,200
Clearing and Grubbing (acres)	2	2	2
Excavation to Embankment (cubic yards)	19,000	19,000	19,000
Embankment Fill (cubic yards)	76,200	76,200	76,200
Closure Expected	Yes	Yes	Yes

Table 2-11. Physical Features for Proposed Road Relocations by Major Road Focus Area for Action Alternatives (contd.)

Road Relocation Features	CP1	CP2	CP3, CP4, CP4A, and CP5
Gillman Road			
Number of Road Segments Affected	-	3	3
Length (linear feet)	-	1,200	1,200
Clearing and Grubbing (acres)	-	1	1
Excavation to Embankment (cubic yards)	-	0	0
Embankment Fill (cubic yards)	-	22,800	22,800
Closure Expected	-	Yes	Yes
Jones Valley and Silverthorn Area			
Number of Road Segments Affected	-	-	3
Length (linear feet)	-	-	1,600
Clearing and Grubbing (acres)	-	-	1
Excavation to Embankment (cubic yards)	-	-	1,500
Embankment Fill (cubic yards)	-	-	13,200
Closure Expected	-	-	Yes
Salt Creek Road			
Number of Road Segments Affected	-	4	5
Length (linear feet)	-	4,300	5,100
Clearing and Grubbing (acres)	-	1	1
Excavation to Embankment (cubic yards)	-	4,100	5,500
Embankment Fill (cubic yards)	-	31,700	33,100
Closure Expected	-	Yes	Yes
Remaining Road Relocations			
Number of Road Segments Affected	3	5	8
Length (linear feet)	2,500	3,500	5,200
Clearing and Grubbing (acres)	0.4	1	2
Excavation to Embankment (cubic yards)	15	120	600
Embankment Fill (cubic yards)	36,400	70,000	81,000
Closure Expected	Yes	Yes	Yes

Key:
- = not applicable
CP = comprehensive plan

Roadway construction activities would involve, but not be limited to, demolition of existing roadways as required; clearing, grubbing, and site preparation of work areas, as required; grading road alignments to meet finished grades; placing road subgrade; paving operations; installing storm drain culverts; constructing retaining wall systems; installing road appurtenances such as guardrails; performing construction-related traffic control; and establishing and maintaining a SWPPP. Noisy equipment, such as pile drivers, is anticipated for road construction work. Typical noise would result from trucks and diesel-powered equipment.

Replacement roadways would be constructed by excavating the existing up-grade slope to provide fill material for the embankment fill portion of road construction; bench-excavating into the up-grade slope above the existing roadway to establish the new road finished grade; building the new road on an engineered fill embankment from imported borrow material; or building the new road directly above the existing road on an engineered fill embankment from imported borrow material. A road alignment may either use a single method of construction for the entire alignment, or use all four methods at different locations along an alignment. To limit impacts on existing roadways, road closures would be avoided whenever possible.

Estimated work limits for road segment relocation are described in the Engineering Summary Appendix. Estimated work limits depend on the surrounding terrain, and vary from a minimum of 5 feet to 30 feet wide, measured from the extent of earthwork. Where the road would be constructed as an embankment fill against an existing steep hillside, a 5-foot-wide minimum work area would be used. Where the terrain beyond the limit of earthwork was flat enough to be used as work areas for construction equipment, the work limits would range from 15 feet to 30 feet wide.

Vehicle Bridges As a result of raising Shasta Dam for any of the action alternatives, the following local road vehicle bridges would be replaced:

- Charlie Creek Bridge
- Doney Creek Bridge
- McCloud River Bridge
- Didallas Creek Bridge

Criteria and assumptions considered in determining structure type and length for the replacement structures are included in the Engineering Summary Appendix. Based on the design criteria and assumptions, and considering preliminary horizontal alignments and profile grades developed for the relocated roadways, Table 2-12 summarizes proposed bridge characteristics for the four road bridges requiring replacement under all comprehensive plans.

Table 2-12. Physical Features of Proposed Vehicular Bridge Relocations Common to All Action Alternatives

Bridge Feature	Charlie Creek Bridge	Doney Creek Bridge	McCloud River Bridge	Didallas Creek Bridge
Bridge Length (linear feet)	782	760	490	115
Number of Abutments	2	2	2	2
Number of Piers	4	4	4	0
Pier Diameter (linear feet)	14	14	6	N/A
Volume of Backfill (cubic yards)	480	400	530	180
Volume of Concrete (cubic yards)	3,530	3,320	2,320	760
Quantity of Steel (tons)	575	516	380	104
Number of Class 140 Piles	24	24	24	24
Number of 24-inch Cast-In-Steel-Shell Piles	72	72	32	N/A
Volume of Excavated Material (cubic yards)	1,200	550	820	440
Quantity of Demolished Material (cubic yards)	3,500	3,300	2,300	800

Key:
N/A = not applicable
SLWRI = Shasta Lake Water Resources Investigation

Construction would take place during the low-water season, and is expected to last between 6 and 8 months. The waterway would remain clear for navigation during construction. Bridge construction would begin with piers and abutments. To allow underwater construction of pier foundations, steel pile shells would be driven into the lake bed to create a temporary cofferdam. It may be necessary to dewater the shells during drilling if water seeps in. A hole would then be drilled to the specified foundation depth. Reinforcing steel would be installed within the shells before concrete was poured. After completion of the piers and abutments, construction of the superstructure and bridge deck would begin via the balanced cantilever method. This process entails forming and constructing the horizontal structure outward from the piers in each direction, in equal (balanced) proportions, until the superstructure/deck segments meet at midspan.

Traffic would continue on the existing bridges during construction. It is likely that barges would be used extensively for vehicular bridge foundation construction, bridge assembly, transport of materials, workers, and equipment, and demolition of the existing bridges. Concrete would be poured from barges. A staging area would be required on the lakeshore, from which barges could be loaded and unloaded.

Although Fender's Ferry Bridge would not need to be replaced as a result of the Shasta Dam raises, modifications to the bridge would be necessary. The Fender's Ferry Bridge is a three-span structure with a steel plate girder superstructure supported on riveted steel tower bents and reinforced concrete piers with spread footings. As a result of differences in east and west riverbank topography, the western pier steel tower is supported at a much lower elevation than the eastern pier tower. Thus, at the proposed full pool elevations, the eastern pier steel tower would be inundated.

The existing reinforced concrete pier and footing would be enlarged and extended, and the existing steel tower modified to prevent inundation as a result of the higher full pool levels associated with the dam raise alternatives under consideration. Proposed modifications include the following:

- Enlarging the existing reinforced concrete footing
- Enlarging and extending the existing reinforced concrete columns and pier wall
- Removing some of the lower portion of the eastern pier steel tower (based on location of existing cross bracing)
- Reusing the existing steel bearing assemblies

Quantities for the major items of work are estimated in the Engineering Summary Appendix.

Construction activities would likely be completed from the existing embankment without constructing cofferdams around the pier because average water surface elevations are below the existing eastern pier bottom-of-footing elevation for all months, with the exception of April and May. Construction of temporary bents to support the superstructure would be necessary to facilitate construction of the pier modifications. During construction activities, temporary traffic controls may be needed to facilitate delivery of materials and construction of temporary support bents.

Railroad Bridges

Pit River Bridge Pier Modification The Pit River Bridge is a multipurpose structure, carrying both UPRR and I-5 traffic. The bridge is both a steel-through truss and a deck truss. UPRR and Caltrans have joint operation and maintenance responsibility. The new full pool elevations would inundate the existing bridge bearings and low-chord steel truss members. To prevent the existing steel bearings and lower portions of the steel truss members from being submerged, a watertight concrete tub structure (bearing protection structure) would be required. The reinforced concrete structure would be attached to the top of two existing concrete piers. The structure footprint would be rectangular, with the top of the structure above the full pool elevation. Elevations for the top of the bearing protection structure and material quantities for Pit River Bridge modifications under each comprehensive plan are shown in Table 2-13.

Table 2-13. Physical Features for Proposed Bearing Protection Structure for Action Alternatives

Item	CP1	CP2	CP3, CP4, CP4A, and CP5
Top of Bearing Protection Structure Elevation (feet)[1]	1082.2	1088.2	1094.2
Concrete (cubic yards)	2,100	2,900	4,000
Reinforcing Steel (pounds)	618,000	876,000	1,200,000

Notes:
[1] Bearing protection structure elevations are based on the North American Vertical Datum of 1988 (NAVD88), which is 2.66 feet higher than the National Geodetic Vertical Datum of 1929. All current feasibility-level designs and figures for reservoir area infrastructure modifications and relocations to accommodate increased water levels are based on a 2001 aerial survey of the reservoir using NAVD88.

Key:
CP = comprehensive plan

Because the existing bridge superstructure and top-of-pier are exposed to the elements, a structure cover would not be required; however, two submersible sump pumps would be installed to keep the water level in the new concrete protective structure from rising near the bearings. Check valves and ball valves would prevent pumped water from draining out of the line back into the sump. Protective grates would prevent large objects from entering the sump area.

Union Pacific Railroad Sacramento 2nd Crossing and Doney Creek Bridge Replacement The superstructures for the existing Sacramento River Second Crossing and Doney Creek railroad bridges consist of deck truss bridges with a single track. The piers and abutments were designed to accommodate a future parallel single-track superstructure. Portions of both bridges would be submerged for any reservoir raise and would need to be replaced with new, higher superstructures. Structural analyses of the existing bridge piers under design earthquake loads indicated that new bridge piers would be required. Therefore, the existing bridges will be removed and replaced with new bridges. The feasibility designs would permit uninterrupted rail service during construction.

The proposed new bridge superstructures would be composite superstructures consisting of steel plate girders and a reinforced concrete deck. In general, the bridge superstructures would be designed to be continuous over the piers. However, with a requirement for 16 feet of vertical clearance between the two westernmost piers for the Sacramento River 2nd Crossing railroad bridge (with a minimum width of 30 feet), to allow for the passage of houseboats, this span is a simply supported span. No minimum clearance for houseboat traffic would be required for the Doney Creek railroad bridge; large-diameter concrete columns with drilled shafts would support the superstructure and be founded on bedrock. The Sacramento River Second Crossing railroad bridge would require nine spans, with a total length of 982 feet between concrete abutments. The Doney Creek railroad bridge would require five spans, with a total length of 537.5 feet between concrete abutments. Construction quantities for major items of work for these features under comprehensive plans are summarized in Table 2-14.

Table 2-14. Physical Features of Proposed Railroad Bridges Common to All Action Alternatives

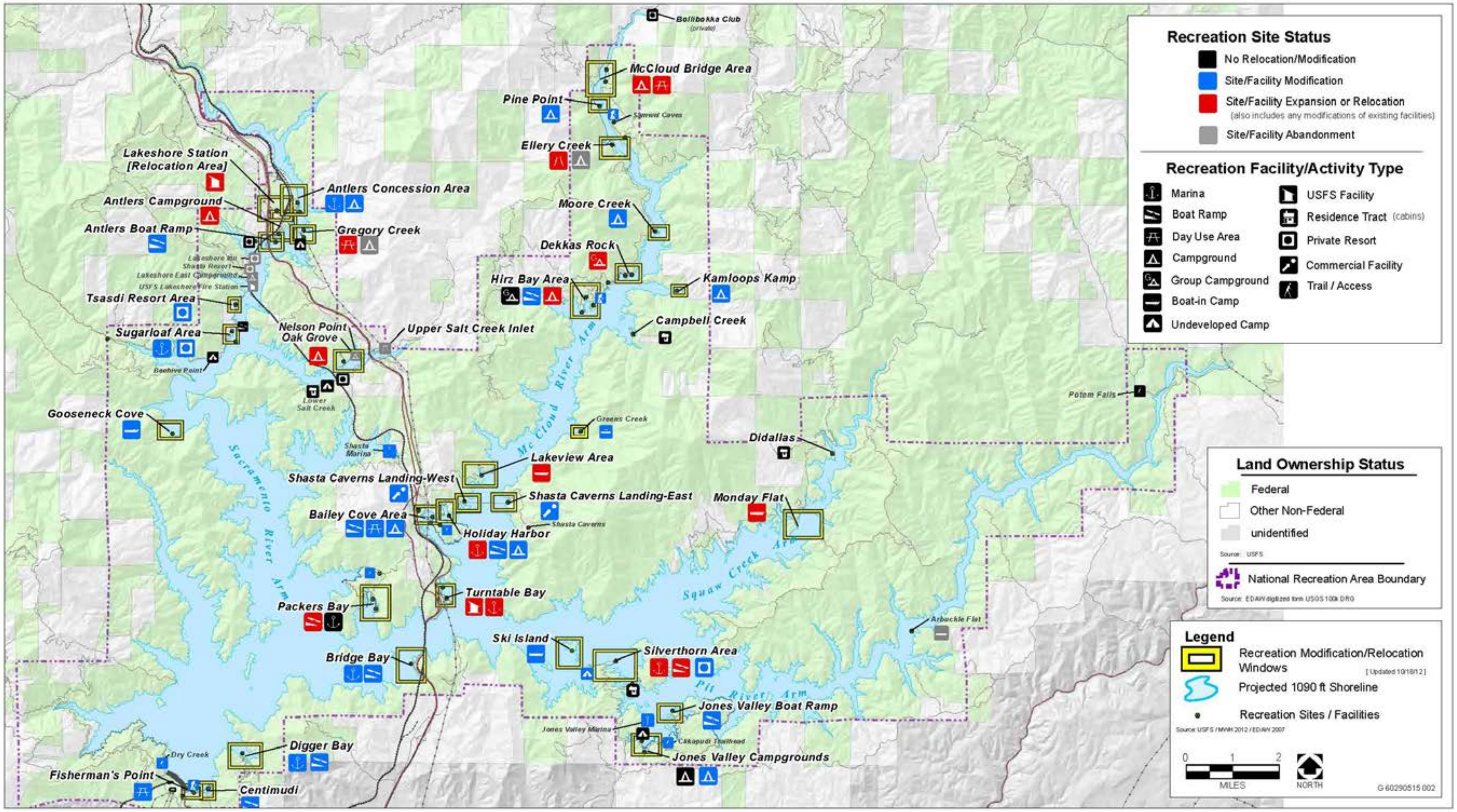
Item	Sacramento River Second Crossing Bridge Quantities	Doney Creek Bridge Quantities
Steel Truss Bridge Removal (pounds)	3,300,000	2,000,000
Concrete Removal (cubic yards)	15,310	4,570
Excavation (cubic yards)	2,100	630
Backfill (cubic yards)	1,900	2,200
Concrete, including Shafts (cubic yards)	11,700	7,080
Reinforcing Steel (pounds)	3,420,000	1,760,000
Structural Steel in Girders (pounds)	4,750,000	2,250,000

The proposed relocation of the UPRR bridges would require that the railroad tracks be realigned between the two bridges. This realignment would parallel the existing tracks with a 25-foot offset to the east. Construction quantities for major items of work for the railroad realignment between the UPRR bridges are summarized in Table 2-15. Any required embankments for this realignment are described under the “Reservoir Area Dikes and Railroad Embankments” section above.

Table 2-15. Physical Features of Proposed Railroad Realignment Common to All Action Alternatives

Item	Railroad Realignment Between Bridges
Length of Track Realignment (linear feet)	8,400
Railroad Track Removal (tons)	370
Ballast Removal (tons)	6,400
Excavation (cubic yards)	35,000
Compacted Backfill (cubic yards)	7,500
Railroad Track (tons)	390
Ballast (tons)	26,500

Recreation Facilities Any raise of Shasta Dam would have some effect on the many recreation features found along the reservoir shoreline. These features include marinas/boat ramps, resorts, campgrounds/day use areas, cabins, trails, and USFS facilities. Areas for potential recreation relocations (referred to as windows) and corresponding relocation plans for each window have been developed. Figure 2-6 details the location of these windows and existing recreation sites with proposed modification, expansion, or relocation activities.



Source: AECOM 2012

Exhibit: Recreation Mitigation Sudy – Summary

Figure 2-6. Recreation Study Windows

The primary goal of the relocation plans is to verify that with any dam raise, the existing recreation capacity could be maintained. Reclamation and USFS will continue to work together to refine recreation relocations and develop a recreation plan that is suitable for the NRA. For recreation facilities on Federal lands, the USFS will consider relevant laws, regulations, policy, special use permits and master development plans to develop and/or provide final approval for any proposed recreation facility relocations. Action alternatives would, at minimum, maintain the existing recreation capacity at Shasta Lake. Inundated recreation facilities and associated utilities would be relocated before demolition to the extent practicable. Scheduling and sequencing of recreation facility relocation construction activities will strive to minimize or avoid interruption to public recreation activities and access to recreation sites. Recreation facilities proposed for relocation are included below in the detailed description of each action alternative. Table 2-16 presents a summary of the recreation facilities to be modified or relocated under each comprehensive plan. Quantities of demolition and construction materials associated with modification and relocation of recreation facilities are listed in Table 2-17.

Table 2-16. Recreation Facilities to be Modified or Relocated Under Action Alternatives

Recreation Facilities	CP1	CP2	CP3, CP4, and CP4A	CP5
Marinas/Public Boat Ramps				
Number of Affected Facilities (marinas/boat ramps)	9/6	9/6	9/6	9/6
Relocation Needed[1] (acres)	8.5	8.5	8.5	8.5
Replacement Structures (square feet)	49,900	49,900	49,900	49,900
Campsites and Day-Use Sites				
Number of Affected Facilities (resorts/campsites and day-use sites)	202	261	328	328
Relocation Needed[1] (acres)	32	34	39	39
Replacement Structures (square feet)	6,200	6,200	6,200	6,200
Resorts/USFS Facilities				
Number of Affected Facilities (resorts/USFS facilities)	6/2	6/2	6/2	6/2
Relocation Needed[1] (acres)	19	19	19	19
Replacement Structures (square feet)	41,000	52,800	68,900	68,900

Table 2-16. Recreation Facilities to be Modified or Relocated Under Action Alternatives (contd.)

Recreation Facilities	CP1	CP2	CP3 and CP4	CP5
Trailheads/Trails				
Number of Affected Facilities (trailheads/trails)	2/9	2/9	2/9	2/9
Relocation Needed[1] (miles)	8.1	9.9	11.6	11.6
Recreation Enhancement[3] (trailheads/trails[miles])	-	-	-	6/18

Note:
[1] Does not include on-site modification of facilities.
[2] For some trails, trailheads are integrated into other recreation facilities. Estimates for standalone trailheads only.
[3] Additional recreation facilities for CP5 only.
Key:
- = not applicable
CP = comprehensive plan
USFS = U.S. Department of Agriculture, Forest Service

Table 2-17. Recreation Demolition and Construction Material Quantities for Action Alternatives

Material	CP1	CP2	CP3, CP4, CP4A, and CP5
Imported Fill (cubic yards)	236,200	384,200	552,800
Excavation to Waste (cubic yards)	592,300	430,600	315,400
Structure Demolition (square feet)	130,700	146,700	164,200
Demolition Waste (cubic yards)	99,200	102,100	105,200

Key:
CP = comprehensive plan

Marina Modifications Several marinas around Shasta Lake would be affected by raising Shasta Dam. Typically, marinas consist of a parking area, a boat ramp, various structures (e.g., retail, restrooms, maintenance facilities, storage, administration), and utilities (power, water, and septic). Most of the effects of the dam raise would result from the inundation of boat ramps, parking lots, structures, and utilities. Boat ramps would be modified in place, on fill, where possible. Parking areas would be replaced on fill, or relocated above the new reservoir elevation. Existing structures that would be inundated would be demolished, and either replaced above the reservoir elevation (upslope or on placed fill), or moved to a floating structure on the water to provide better access for recreational users. Any access roads would be relocated above the new full pool for continued access around the marinas. Existing septic systems that would be inundated would be demolished and removed from the area or relocated. New facilities could also be connected to new localized wastewater treatment facilities. Power lines would be installed to accommodate new structures.

To maintain shoreline accessibility and facility distribution around the lake, each affected marina would be relocated in the immediate vicinity of its existing location. Relocation of marinas in their existing location is the most cost effective approach to maintaining marina-related recreation capacity at Shasta Lake. If unforeseen circumstances prevent affected marinas from being maintained in their current location, relocating or consolidating with other marinas would be reconsidered. Although not anticipated, potential new or expanded areas that could be used include:

- Silverthorn Marina Area
- Turntable Bay Area
- Holiday Harbor Marina Area

Public Boat Ramp Modifications Six public boat ramps that could be inundated would be modified or relocated in the immediate vicinity. Public boat ramps that could not be modified in place would be relocated to adjacent areas that can provide the necessary grade and access for ramps. To maintain current recreation capacity of public boat ramps the following potential new or expanded areas could be used:

- Antlers Public Boat Ramp Area
- Packers Bay Public Boat Ramp Area

Resort Modifications Raising Shasta Dam would affect approximately six resorts around the reservoir to some degree. Inundated structures and structures within 3 vertical feet of the new full pool would be demolished. Septic systems would also be demolished, and remaining structures would either be connected to new localized wastewater treatment facilities or be relocated to other septic systems. To maintain the current recreation capacity of the resorts, the Antlers Concession Area could be used.

Campground/Day Use Area Modifications Many undeveloped areas have been identified as potential campgrounds to replace capacity lost because of inundation. While some inundated campgrounds would be relocated on fill at their existing location, others would be moved around the reservoir to new locations identified as potential campground sites. To maintain the current recreation capacity of campgrounds, the following potential new or expanded areas could be used:

- Antlers Campground
- Oak Grove Campground

- Hirz Bay Campground
- McCloud Bridge Area

The following potential new or expanded areas could be used to meet the need for boat-in campgrounds:

- Former Lakeview Marina Area
- Monday Flat Boat-In Camp

The following potential new or expanded areas could be used to meet the need for day-use areas:

- Ellery Creek Campground
- Gregory Creek Campground
- McCloud Bridge Area

USFS Facilities Modifications Recreation within the NRA is managed by USFS, which has several facilities located throughout the reservoir area. USFS facilities consist of various storage and maintenance buildings and equipment, fire protection equipment, customer service facilities, office space, and employee living facilities. Two USFS facilities would be inundated and would require relocation or replacement. The station located in the Lakeshore area would be inundated by a Shasta Dam raise, and would be relocated to an area above the new full pool. The new facility would contain all of the features that exist at the current facility. The inundated facility would be demolished, and hauled to waste. Turntable Bay, another USFS facility, would be inundated by a Shasta Dam raise. Additional space at Turntable Bay would allow the facility to be relocated on fill in its current location.

Nonrecreation Structures Under all comprehensive plans, nonrecreational residential and commercial structures affected by inundation would require demolition. These structures would be demolished by appropriately licensed contractors. All utilities would be disconnected, capped, and/or removed per permit requirements and governing utility standards. The structure and foundation would then be demolished. Asbestos material, if discovered, would be removed and taken to an approved landfill for disposal per permit requirements. General demolition waste would also be removed and trucked to an approved landfill. Table 2-18 shows the total volume of demolished material for nonrecreational structures by comprehensive plan.

Table 2-18. Nonrecreation Structures Demolition Quantities for Action Alternatives

Demolition	CP1	CP2	CP3, CP4, CP4A, and CP5
Structure Demolition (square feet)	8,700	21,500	27,000
Total Volume of Material (cubic yards)	1,300	3,200	4,000

Key:
CP = comprehensive plan

Utilities and Miscellaneous Minor Infrastructure Gas/petroleum facilities, potable water facilities, power and telecommunications infrastructure, and wastewater facilities would be relocated if affected physically by inundation or if the facilities (such as septic systems) would no longer meet Shasta County Development Standards. The relocation numbers or lengths of facility features to be relocated during proposed utility relocations are shown for each comprehensive plan in Table 2-19. New facilities would be designed and constructed in accordance with applicable Federal, State, and local codes and requirements. Relocated facilities would be of the same types, sizes, and materials as existing facilities where feasible. For relocation of wastewater treatment facilities, new septic systems may be constructed on the property if they meet Shasta County requirements for separating septic systems from the lake. Otherwise, the comprehensive plans include facilities for pressurized sewer collection systems to transport wastewater flows to centralized package wastewater treatment plants.

Demolished facilities would not be reused to construct relocated facilities. Demolished and relocated utilities are summarized as part of the detailed description of each action alternative. The approach and methodology for demolition, design, and relocation criteria for each category of utilities are discussed in greater detail in the Engineering Summary Appendix.

Table 2-19. Physical Features for Proposed Utilities Relocations for Action Alternatives

Utility Type	CP1	CP2	CP3, CP4, CP4A, and CP5
Potable Water Facilities			
Length of Waterlines Relocated (linear feet)	7,200	8,500	11,000
Wells/Tanks Relocated (number)	12	13	10
Pump Stations Relocated (number)	2	2	3
Length of Waterline Demolished (linear feet)	8,900	11,200	14,800
Wells/Tanks Demolished (number)	16	28	25
Pump Stations Demolished (number)	2	2	3

Table 2-19. Physical Features for Proposed Utilities Relocations for Action Alternatives (contd.)

Utility Type	CP1	CP2	CP3, CP4, CP4A, and CP5
Gas/Petroleum Facilities			
Tanks Relocated (number)	7	10	10
Tanks Demolished (number)	7	10	10
Wastewater Facilities			
Septic Systems Relocated[1] (number)	14	19	19
Vault/Pit Toilets Relocated (number)	2	2	2
Pump Stations Relocated (number)	1	1	1
Length of Wastewater Pipe Relocated (linear feet)	400	400	430
Septic Systems Demolished[2] (number)	211	239	266
Vault/Pit Toilets Demolished (number)	2	2	2
Pump Stations Demolished (number)	2	2	2
Length of Wastewater Pipe Demolished (linear feet)	2,300	2,300	2,400
Package Wastewater Treatment Plants[3] (number)	Up to 6	Up to 6	Up to 6
Power Distribution Facilities			
Power Lines Relocated (linear feet)	34,520	40,565	42,050
Power Towers Relocated (number)	11	11	11
Power Lines Demolished (linear feet)	33,227	44,565	43,045
Power Towers Demolished (number)	26	26	26
Telecommunications			
Copper Wire Relocated (linear feet)	27,900	30,200	33,400
Fiber-Optic Cable Relocated (linear feet)	4,300	5,800	5,800
Copper Wire Demolished (linear feet)	23,600	27,800	31,200
Fiber-Optic Cable Demolished (linear feet)	3,600	5,200	5,200

Note:
[1] Does not include septic systems replaced with new sewer connections.
[2] Includes demolition of septic systems to be relocated, replaced with new sewer connections, and removed without relocation or replacement.
[3] Includes additional lift stations, force main, laterals, and holding tank pumps/valves not shown.
Key:
CP = comprehensive plan

Spawning Gravel Augmentation Under CP4, CP4A, and CP5

Under CP4, CP4A, and CP5, gravel augmentation would occur at one to three locations between Keswick Dam and the RBPP every year for a period of 10 years, unless unusual conditions or agency requests precluded placement during a single year. Construction activities would vary significantly by location, but generally would include clearing, grubbing, and some grading of new access routes to allow construction vehicles to access the river. At several locations, clearing and grubbing of the riverbank would be required to allow gravel to be placed on the bank for recruitment. Gravel would be delivered to the locations by dump trucks. In most cases, gravel would be stockpiled in a staging area and moved with bulldozers, loaders, and/or excavators. Dust control trucks would be present during all construction activities.

Several locations would require in-water construction work. Generally, this involves building gravel out into the river channel “step-wise,” meaning that gravel is dumped and leveled, and the leveled area serves as a working platform for the next step of construction. This practice is common for spawning gravel placement, and minimizes the extent to which construction vehicles drive directly through an active river channel. One or two locations, however, would require construction activity in the active river channel, where construction vehicles would deposit gravel and raise the grade of the river near existing riffles.

Riparian, Floodplain, and Side Channel Habitat Restoration Under CP4, CP4A, and CP5

Under CP4, CP4A, and CP5, riparian, floodplain, and side channel habitat restoration would be constructed at one or more suitable locations along the upper Sacramento River to benefit anadromous fish and other aquatic and riparian species. Several potential sites exist along the upper Sacramento River between Keswick Dam and RBPP that would be suitable for these restoration measures. Construction activities for riparian, floodplain, and side channel habitat restoration would vary depending on the location or locations selected and type of restoration measure to be implemented at the site. In general, construction activities would include earth moving activities with bulldozers, loaders, excavators, and/or compactors. Vegetation removal may also be necessary at some sites, either for channel deepening/widening, or where water with aquatic vegetation is present in a channel pending modification.

Special precautions for restoration at these sites will primarily involve:

- Maintaining the active spawning areas in proximity to the site
- Avoiding the creation of habitat for predacious fish
- Minimal disruptions to navigability of the river
- Preventing the spread of invasive, non-native plant species
- Ensuring the safety of homes located along the Sacramento River downstream from the sites

The following are examples of construction measures proposed for restoration of riparian, floodplain, and side channel habitat at each of the potential restoration sites.

Henderson Open Space An existing side channel to the main stem of the Sacramento River would be enhanced to activate the frequency and duration of flows for Chinook salmon spawning habitat throughout a portion of Henderson Open Space Park. The enhancement would involve modifying the northern opening to the existing side channel to restore connectivity with the river at flows greater than 8,000 cfs. Minor grading and channel slope modification would be necessary to rework the existing (sometimes inundated) channel to a point at which flows may be activated for spawning habitat.

The existing Henderson Open Space side channel is heavily vegetated. Floodplain terraces and adjacent riparian areas would be replanted with native vegetation after the completion of earth-moving activities. A more detailed site analysis would determine the mix, composition, and density of the riparian vegetation plantings. To varying degrees, temporary fencing and irrigation would be necessary to protect and sustain newly established riparian vegetation.

Tobiasson Island A regularly flowing side channel would be created to increase spawning habitat for all runs of Chinook salmon at Tobiasson Island. Creating this side channel would involve excavating a trapezoidal-shaped channel, the base of which would correspond to an elevation that would allow flows of 5,000 cfs or greater to enter the side channel, hence hydraulically connecting it to the Sacramento River. If created, this new side channel would add approximately 1,350 linear feet of salmonid spawning habitat to this section of the Sacramento River.

The potential site for the channel to be cut does not currently have flowing water or riparian vegetation: therefore, vegetation removal would not be necessary. However, upon completion of earth-moving activities, it would be necessary to establish native vegetation throughout the side channel on the newly created floodplain terraces. A more detailed site analysis would determine the mix, composition, and density of the riparian vegetation plantings. Temporary irrigation and fencing for vegetation planting at this site is not feasible because the site lacks water supply and electricity.

Shea Island Complex Restoration at the Shea Island Complex would involve lowering a section of the upstream end of the major side channel through the site. The objective would be to keep water moving through the channel when the Sacramento River reaches flows of 10,000 cfs or greater, thus enhancing salmonid spawning habitat.

Additionally, removal of vegetation and debris would be necessary in both the excavated portion of the channel and other portions of the channel to insure the connectivity of flows. Minor grading activity could increase channel complexity along the length of the corridor. Upon completion of earth-moving activities, it would be necessary to establish native vegetation throughout the side channel on the newly created floodplain terraces. A more detailed site analysis would determine the mix, composition, and density of the riparian vegetation plantings. Temporary irrigation and fencing for vegetation planting at this site is because the site lacks a water supply and electricity.

Kapusta Island An existing side channel on Kapusta Island would be enhanced to increase spawning habitat for winter-run and spring-run Chinook salmon in the Sacramento River. This enhancement would involve lowering the channel bed so that the channel may be hydraulically connected to the Sacramento River when the river is flowing in excess of 10,000 cfs.

A trapezoidal cut would need to occur along the course of the side channel, which is inundated only infrequently; in addition, vegetation and debris would need to be removed. Upon completion of earth-moving activities, establishing vegetation on new floodplain terraces and adjacent riparian areas with native plants would be necessary. A more detailed site analysis would determine the mix, composition, and density of the riparian vegetation plantings. Temporary fencing or irrigation at this site for newly established riparian vegetation is highly infeasible and a planting mix would need to be selected with this limitation in mind.

Anderson River Park Restoring floodplain, riparian and side channel habitat at Anderson River Park would involve altering a relic Sacramento River side channel located in the southeastern portion of the park at river flows of, or above 8,000 cfs or more. The side channel rearing habitat would be created by altering the upstream end of the side channel to capture flows. At present, the side channel is seasonally inundated, but likely by way of seepage from the river through alluvial material. Riparian vegetation and appurtenant biota are at this site; therefore, removal of vegetation to lower the channel bed would be necessary, followed by post excavation replanting of native riparian vegetation.

Reading Island Restoring floodplain, riparian, and side channel habitat at Reading Island would involve hydraulically reconnecting Anderson Creek with the Sacramento River at flows ranging between 4,000 cfs and 6,000 cfs. To restore Sacramento River flows through Anderson Creek, it would first be necessary to breach the levee that creates Anderson Slough. Additionally, clearing and excavation of the side channel would be necessary to ensure flows through the channel. This would involve removing vegetation and debris and deepening the existing channel.

After excavation, floodplain terraces and adjacent riparian areas would need to be vegetated with native plants. This would require temporary irrigation and fencing to sustain plantings and keep livestock off site. A more detailed site analysis would determine the mix, composition, and density of the riparian vegetation plantings.

Shasta Lake Tributary and Shoreline Enhancement Under CP5

Structural enhancements associated with CP5 include placing brush structures constructed from whiteleaf manzanita (*Arctostaphylos manzanita*) in the Shasta Lake littoral zone. Because of manzanita's density, installation would not require using anchor or cabling techniques that could result in ancillary negative impacts (e.g., maintenance, hazards to boaters). The brush structures would be assembled in the drawdown zone of the reservoir in an area that would be inundated as the reservoir surface elevation rises in fall. The brush structures are expected to be about 1,800 cubic feet in size. The establishment period would be the first year after construction; life span of the brush structures is projected to be 10 years.

Table 2-20 identifies the general area, number, and size of proposed structural enhancement locations for the main body of Shasta Lake, and the Pit, Sacramento, McCloud, Big Backbone, and Squaw arms. Selection of specific locations has been deferred so that enhancement locations are consistent with other project objectives. The level of proposed treatment is based on the proportion of available manzanita surrounding Shasta Lake. In general terms, these locations would incorporate available material at locations with preferred topographic features; preferred locations are coves that offer steep drawdown areas during the primary use period (spring, early summer).

Table 2-20. Proposed Structural Enhancement of Shasta Lake's Main Body and by Arms Under CP5

Area	Area Treated (acres)	Number of Locations
Main Body	17	595
Pit	12	420
Sacramento	43	1,505
McCloud	8	280
Big Backbone	3	105
Squaw	17	595
Total	**100**	**3,500**

Key:
CP = Comprehensive Plan

Vegetative enhancements associated with CP5 include planting willows to enhance nearshore fish habitat, and aerial and hand seeding of annual native grasses to treat shoreline areas at Shasta Lake.

More than 30 acres could be available to enhance the willow recruitment adjacent to Shasta Lake. Rooted willows would be planted in draws and other moist sites, such as springs, to provide long-term live cover. The establishment period for willows would be the first year after construction; life span is projected to be 5 to 50 years. The establishment period for native grasses would also be the first year of construction, with the life span projected to be 1 to 3 years. This approach would require native seed and nursery stock; several years of advanced preparation would be needed before planting could take place.

Table 2-21 summarizes proposed enhanced treatment with native willows and grasses for the main body of Shasta Lake and by the lake's arms.

Table 2-21. Proposed Vegetative Enhancement Treatment of Shasta Lake's Main Body and Arms under CP5

Area	Willow Planting (acres)	Native Grass Seeding (acres)
Main Body	1	2
Pit	1	4
Sacramento	7	4
McCloud	1	2
Big Backbone	3	2
Squaw	1	2
Total	**14**	**16**

Key:
CP = Comprehensive Plan

Construction Staging

Reclamation would establish staging areas for equipment storage and maintenance, construction materials, fuels, lubricants, solvents, and other possible contaminants in coordination with the resource agencies. Staging areas would likely be located within disturbed areas or at existing facilities that are expected to be inundated, such as campgrounds, recreation parking facilities, the top of Shasta Dam, and the parking area along the left wing dam, where feasible.

Staging areas would have a stabilized entrance and exit and would be located at least 100 feet from bodies of water, if possible. Should an off-road site be chosen, qualified biological and cultural resources personnel would survey the selected site to verify that no sensitive resources would be disturbed by staging activities. Should sensitive resources be found, an appropriate spatial and temporal buffer zone would be staked and flagged to avoid impacts. Where possible, no equipment refueling or fuel storage would take place within 100 feet of a body of water.

Construction Schedule, Equipment, and Workforce

The total duration of construction for major facilities is estimated to range from 4.5 to 5 years for all comprehensive plans. An overlap is expected in the timing of a majority of the construction components. Construction would be phased, when feasible, to avoid environmental impacts. Depending on the amount of concurrent work allowed, the critical work elements that would allow for additional storage of water in the reservoir could be completed in 3.5 years.

Construction would typically occur during daylight hours, Monday through Friday. However, construction contractors may extend these hours and schedule construction work on weekends, if necessary, to complete aspects of the work within a given time frame. Construction would require typical heavy construction equipment including excavators, backhoes, bulldozers, scrapers, graders, water trucks, front-end loaders, dump trucks, drill rigs, pump trucks, truck-mounted cranes, pickup trucks, barges, helicopters, and miscellaneous equipment.

Daily highway truck trips would be required to bring construction material to the site, and carry construction debris and waste material to a suitable landfill. Estimated daily highway truck trips for each comprehensive plan are shown in Table 2-22. Table 2-22 also shows the estimated construction period and annual construction labor force for each comprehensive plan.

Table 2-22. Estimated Construction Period, Truck Trips, and Construction Labor Force for Action Alternatives

Construction Item	CP1	CP2	CP3	CP4/ CP4A	CP5
Construction Period (years)	4.5	5	5	5	5
Construction Labor Force (number/year)	300	300	350	350	360
Daily Truck Trips for Materials (trips/day)	95	118	168	175	177
Daily Truck Trips for Waste (trips/day)	75	56	52	53	54
Total Daily Truck Trips (trips/day)	170	173	220	228	230

Key:
CP = comprehensive plan

Borrow Sources

Multiple borrow sources are available to meet project needs for concrete, sand and gravel, core and homogenous fill, shell fill, riprap, and filter and drain materials for reservoir area embankments. Potential borrow sources were examined at a preliminary level and would need further sampling and testing to determine suitability and refine quantity estimates. Potential borrow sources include areas of the dike construction sites, areas located below the reservoir's inundation zone, and commercial sources. Commercial sources are located within approximately 2 to 30 miles of the Bridge Bay site, and within approximately 15 to 43 miles of the Lakeshore sites. Potential borrow sources are identified in Figure 2-7. Available fill material from potential borrow sources are described in the Engineering Summary Appendix.

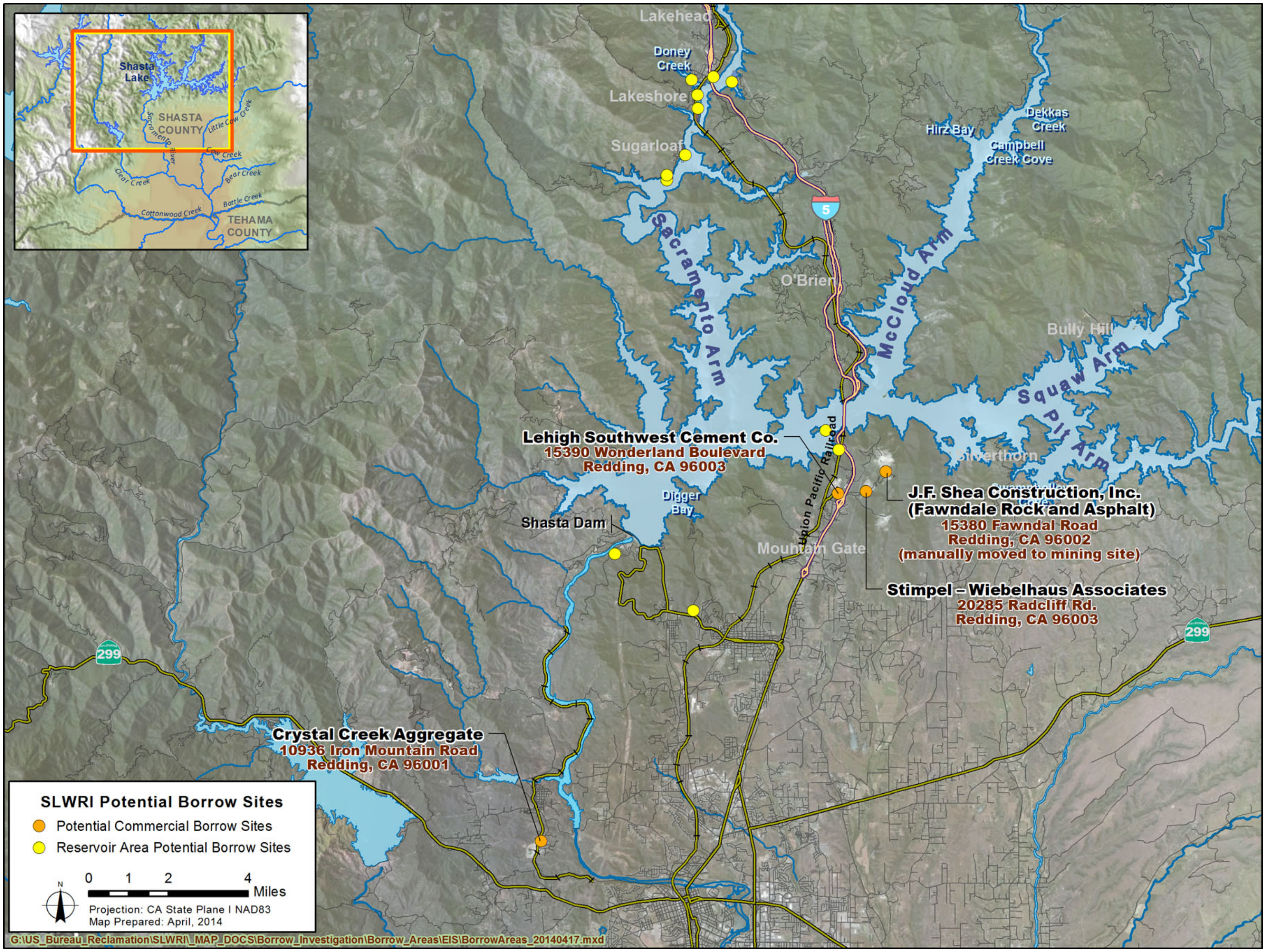


Figure 2-7. Potential Borrow Sources

2.4 Alternatives Considered and Eliminated from Further Analysis

As noted above, this EIS tiers to the CALFED EIS/R, and the CALFED agencies considered more than 50 water supply alternatives through the CALFED process. The CALFED Programmatic ROD directed that five storage projects be further studied, including Shasta Dam and Reservoir. The CALFED Programmatic ROD further recognizes that CALFED agencies "will not revisit the alternatives that were considered alongside CALFED's Preferred Program Alternative nor will they revisit alternatives that were rejected during CALFED's alternative development process."

In addition to the action alternatives described in Section 2.3, "Action Alternatives," Reclamation examined numerous other alternatives through its plan development process, which is detailed in the Plan Formulation Appendix.

Alternatives considered but eliminated from further analysis are described below. The plans described were developed during the initial alternatives phase and the comprehensive plans phase, consistent with the alternatives development process discussed previously.

As part of the SLWRI plan formulation process, Reclamation identified, evaluated, and screened more than 60 potential management measures (shown in Table 2-1) to address the primary and secondary planning objectives and satisfy the other applicable planning constraints, considerations, and criteria. In addition to modifying or raising Shasta Dam, Reclamation considered management measures including constructing instream fish habitat on tributaries to the Sacramento River; increased instream flows on Clear, Cow, and Bear creeks; constructing a migrating corridor from the Sacramento River to the Pit River; new reservoirs in other locations, such as on the Sacramento River upstream from Shasta Reservoir, on tributaries downstream from Shasta Dam (e.g., Cottonwood Creek and Auburn Dam Projects); offstream storage near the Sacramento River downstream from Shasta Dam (e.g., Sites Reservoir); and many others. Management measures deleted from further consideration were summarized previously and are described in detail in the Plan Formulation Appendix, along with reasons for deleting measures from further consideration and development.

2.4.1 Initial Alternatives Phase

The following concept plans were eliminated from further consideration as stand-alone plans.

- **AFS-1 – Increase Cold Water Assets with Shasta Operating Pool Raise (6.5 feet) –** AFS-1 focused on maintaining cooler water temperatures in the upper Sacramento River by increasing the minimum end-of-October carryover storage target. This would allow additional cold water to be stored for use in the following year. No changes would be made to the existing seasonal temperature targets for anadromous fish on the upper Sacramento River, but the ability to meet these targets would be improved.

It was found that AFS-1 had a significant potential to benefit anadromous fish in the upper Sacramento River, but there would be no additional increase in water supply reliability. This plan had two major components: (1) Raising Shasta Dam by 6.5 feet for the primary purpose of enlarging the cold-water pool and regulating water temperature in the upper Sacramento River: and (2) increasing the size of the minimum operating pool to 880,000 acre-feet.

AFS-1 was not retained for further development as a stand-alone plan because, although it had considerable benefits for anadromous fish survival, it did not meet the primary planning objective of increasing water supply reliability.

- **AFS-2 – Increase Minimum Anadromous Fish Flow with Shasta Enlargement (6.5 feet) –** AFS-2 focused on the primary planning objective of anadromous fish survival by using the additional reservoir storage to increase minimum seasonal flows in the upper Sacramento River from the current 3,250 cfs to about 4,200 cfs. The primary component of AFS-2 included raising Shasta Dam by 6.5 feet for the primary purpose of enlarging the volume of water available to meet minimum flows for winter-run Chinook salmon on the upper Sacramento River. No changes would be made to the carryover target volume or minimum operating pool.

  Subsequent evaluation indicated that although increasing minimum flows would be beneficial for fish at various stages of development, it would be detrimental at other life stages. Accordingly, this plan was deleted from further development.

- **AFS-3 – Increase Minimum Anadromous Fish Flow with Shasta Enlargement (6.5 feet) and Restore Aquatic Habitat –** AFS-3 was similar to AFS-2, except that it also involved acquiring, restoring, and reclaiming one or more inactive gravel mines along the upper Sacramento River to restore about 150 acres of aquatic and floodplain habitat. AFS-3 had two major plan components: (1) Raising Shasta Dam by 6.5 feet for the primary purpose of enlarging the volume of water available to meet minimum flows for winter-run Chinook salmon on the upper Sacramento River: and (2) acquiring, restoring, and reclaiming one or more inactive gravel mining operations along the upper Sacramento River to restore about 150 acres of aquatic and floodplain habitat.

Increasing minimum flows was not found to significantly benefit to anadromous fish, and concerns were expressed regarding significant uncertainties about offstream areas being able to successfully support viable fish spawning and rearing. Further, during public scoping activities in late 2005, little to no interest was demonstrated for restoring inactive gravel mines along the Sacramento River above the current location of the RBPP. Accordingly, this plan element was deleted from further consideration at this time.

- **WSR-3 – Increase Water Supply Reliability with Shasta Enlargement (High Level) –** WSR-3 focused on water supply reliability by increasing the volume of water stored in Shasta Lake by the maximum amount technically feasible. WSR-3 had two major components: (1) Raising Shasta Dam by about 202.5 feet for the primary purpose of creating 9.3 MAF of additional storage available for water supply: and (2) major modifications to or replacing, dam appurtenances, including hydropower facilities and the TCD.

  Raising the dam to this level would require extensive and very costly reservoir area relocations such as moving the Pit River Bridge, I-5, and UPRR tracks, and would require modifying Keswick Dam and its powerplant. This plan would provide a major increase in water supply reliability, anadromous fish, hydropower, flood damage reduction, and recreation resources. However, the plan is not financially feasible because the construction cost is estimated at more than $6 billion (at October 2008 price levels). Accordingly, WSR-3 was deleted from further development.

- **WSR-4 – Increase Water Supply Reliability with Shasta Enlargement (18.5 feet) and Conjunctive Water Management –** WSR-4 focused on the primary objective of water supply reliability by raising Shasta Dam 18.5 feet in combination with conjunctive water management. WSR-4 had two major components: (1) Raising Shasta Dam by 18.5 feet for the primary purpose of creating 636,000 acre-feet of additional storage available for water supply and (2) implementing a conjunctive water management program, consisting largely of contracts between Reclamation and certain Sacramento River basin water users. The conjunctive water management component included downstream facilities, such as additional river diversions and transmission and groundwater pumping facilities, to facilitate exchanges. Reclamation would provide additional surface supplies to participating CVP users in wet and normal water years, in exchange for reducing deliveries in dry and critical years, when users would rely more on groundwater supplies.

  Preliminary estimates of the conjunctive water management component associated with this alternative indicated that water supplies for system deliveries could be increased by between 10 and 20 percent. However, few to no fishery benefits would result and no strong indication of non-Federal participation in a conjunctive water management component was identified. Accordingly, WSR-4 was deleted from further consideration.

- **CO-1 and CO-2 – Increase Anadromous Fish Habitat and Water Supply Reliability with Shasta Enlargement (6.5 feet and 18.5 feet) –** CO-1 and CO-2 addressed both primary objectives by restoring anadromous fish habitat and raising Shasta Dam. Both CO-1 and CO-2 would dedicate some of the added reservoir space from the dam raise to increasing the minimum carryover storage in Shasta Reservoir to make more cold-water releases for regulating water temperature in the upper Sacramento River. CO-1 and CO-2 had three major components: (1) Raising Shasta Dam by 6.5 feet (CO-1) or 18.5 feet (CO-2), for the purposes of expanding the cold-water pool and creating 260,000 acre-feet (CO-1) or 630,000 acre-feet (CO-2) of additional storage available for water supply; (2) acquiring, restoring, and reclaiming one or more inactive gravel mining operations along the upper Sacramento River to create about 150 acres of aquatic and floodplain habitat, and (3) revising flood control operations to benefit water supply reliability by managing floods more efficiently.

  For reasons similar to those described for AFS-3, both CO-1 and CO-2 were eliminated as stand-alone plans, and the gravel mine restoration components of both plans were deleted from further consideration.

- **CO-3 –** Increase Anadromous Fish Flow/Habitat and Water Supply Reliability with Shasta Enlargement (18.5 feet). CO-3 is similar to CO-2, except that a portion of the additional storage would be dedicated to managing flows for winter-run Chinook salmon on the upper Sacramento River. Under this preliminary plan, approximately 320,000 acre-feet would be dedicated to increasing minimum flows from approximately 3,250 cfs to about 4,200 cfs between October 1 and April 30.

  Subsequent evaluation indicated that although increasing minimum flows would be beneficial for fish at various stages of development, it would be detrimental at other life stages. Accordingly, CO-3 was deleted from further development.

- **CO-4 – Multipurpose with Shasta Enlargement (6.5 feet) –** This plan addressed both the primary and secondary objectives through a combination of measures, raising Shasta Dam, restoring habitat, and adding recreation facilities in the Shasta Lake area. Enlargement of the reservoir and limited reservoir reoperation would also help improve operations for flood management and recreation. Major components of

CO-4 involved increasing water supply reliability with a 6.5-foot dam raise, increasing anadromous fish survival by increasing cold-water pool depth and volume in Shasta Reservoir, and restoring inactive gravel mines and floodplain habitat along the Sacramento River. CO-4 involved further investigation of and potential modifications to the existing TCD at Shasta Dam for enhanced temperature management, and increasing the operational efficiencies of Shasta Dam and Reservoir for water supply reliability and flood control. Finally, the plan involved implementing conjunctive water management, as in WSR-4, constructing shoreline and tributary fish habitat improvements in the Shasta Lake area, and restoring one or more riparian habitat areas between Redding and the current location of the RBPP on the Sacramento River.

CO-4 was eliminated from further consideration primarily because of its low effectiveness and efficiency and redundancies with WSR-1 and CO-5, both of which were recommended for further development.

2.4.2 Comprehensive Plans Phase

The scenarios presented in Tables 2-23 and 2-24, related to the formulation of the anadromous fish survival focus plan (CP4/CP4A), were eliminated from further consideration during the comprehensive plans phase.

Table 2-23. Eliminated Scenarios Considered to Augment Flows – Anadromous Fish Survival Focus Plan

Scenario	Description	Reason for Elimination
1	Dam raise of 18.5 feet. Additional 634,000 acre-feet of storage. October – March AFRP flows or 500 cfs increase, whichever is less.	Analysis indicated limited benefits to fish compared with overall cost of the project.
2	Dam raise of 18.5 feet. Additional 634,000 acre-feet of storage. October – March AFRP flows or 750 cfs increase, whichever is less.	Analysis indicated limited benefits to fish compared with overall cost of the project.
3	Dam raise of 18.5 feet. Additional 634,000 acre-feet of storage. October – March AFRP flows or 1,000 cfs increase, whichever is less.	Analysis indicated limited benefits to fish compared with overall cost of the project.
4	Dam raise of 18.5 feet. Additional 634,000 acre-feet of storage. Increase August flows to 10,000 cfs and September flows to 6,000 cfs for temperature control.	Analysis indicated limited benefits to fish compared with overall cost of the project.

Source: USFWS 2001
Key:
AFRP = Anadromous Fish Restoration Plan
cfs = cubic feet per second

Table 2-24. Eliminated Scenarios Considered for Cold-Water Storage – Anadromous Fish Survival Focus Plan

Scenario	Description	Reason for Elimination
B	Dam raise of 6.5 feet. Additional 256,000 acre-feet of storage. Dedicating 256,000 acre-feet of water from increased storage to increase the size of the cold-water pool for fishery benefit.	Although this scenario had considerable benefits for anadromous fish survival, it did not considerably contribute to other objectives.
D	Dam raise of 12.5 feet. Additional 443,000 acre-feet of storage. Dedicating 187,000 acre-feet of the additional water from increased storage to increase the size of the cold-water pool for fishery benefit.	Although this scenario had considerable benefits for anadromous fish survival, it was not as cost-effective as an 18.5-foot raise.
E	Dam raise of 12.5 feet. Additional 443,000 acre-feet of storage. Dedicating 443,000 acre-feet of water from increased storage to increase the size of the cold-water pool for fishery benefit.	Although this scenario had considerable benefits for anadromous fish survival, it did not considerably contribute to other objectives.
I	Dam raise of 18.5 feet. Additional 634,000 acre-feet of storage. Dedicating 634,000 acre-feet of water from increased storage to increase the size of the cold-water pool for fishery benefit.	Although this scenario had considerable benefits for anadromous fish survival, it did not considerably contribute to other objectives.

Further information about the SLWRI plan formulation process, including detailed descriptions of deleted and retained measures, initial plans, and scenarios used to formulate CP4/CP4A, are presented in the Plan Formulation Appendix.

2.5 Summary of Potential Benefits of Action Alternatives

Table 2-25 summarizes the overall potential benefits of all comprehensive plans. The quantified benefits were based on modeling efforts that are described in several parts of the EIS: Chapter 6, “Hydrology, Hydraulics, and Water Management;” Chapter 11, “Fisheries and Aquatic Resources;” Chapter 23, “Power and Energy;” and the modeling appendices.

Table 2-25. Summary of Major Benefits of Action Alternatives

Item	CP1	CP2	CP3	CP4	CP4A	CP5
Shasta Dam Raise (feet)	6.5	12.5	18.5	18.5	18.5	18.5
Total Increased Storage (TAF)	256	443	634	634	634	634
Benefits						
Increase Anadromous Fish Survival						
Dedicated Storage (TAF)	-	-	-	378	191	-
Production Increase (thousand fish)[1]	61	379	207	813	710	378
Spawning Gravel Augmentation (tons)[2]	-	-	-	10,000	10,000	10,000
Side Channel Rearing Habitat Restoration	-	-	-	Yes	Yes	Yes

Table 2-25. Summary of Major Benefits of Action Alternatives (contd.)

Item	CP1	CP2	CP3	CP4	CP4A	CP5
Increase Water Supply Reliability						
Total Increased Dry and Critical Year Water Supplies (TAF/year)[3]	47.3	77.8	63.1	47.3	77.8	113.5
Increased NOD Dry and Critical Year Water Supplies (TAF/year)[3]	4.5	10.7	35.2	4.5	10.7	25.2
Increased SOD Dry and Critical Year Water Supplies (TAF/year)[3]	42.7	67.1	28.0	42.7	67.1	88.3
Increased Water Use Efficiency Funding	Yes	Yes	Yes	Yes	Yes	Yes
Increased Emergency Water Supply Response Capability	Yes	Yes	Yes	Yes	Yes	Yes
Reduce Flood Damage						
Increased Reservoir Storage Capacity	Yes	Yes	Yes	Yes	Yes	Yes
Additional Hydropower Generation[4]						
Increased Hydropower Generation (GWh/year)[5]	52 - 54	87 - 90	86 - 90	127 - 133	125 - 130	112 - 117
Conserve, Restore, and Enhance Ecosystem Resources						
Shoreline Enhancement (acres)	-	-	-	-	-	130
Tributary Aquatic Habitat Enhancement (miles)[6]	-	-	-	-	-	6
Riparian, Floodplain, and Side Channel Restoration Habitat	-	-	-	Yes	Yes	Yes
Increased Ability to Meet Flow and Temperature Requirements Along Upper Sacramento River	Yes	Yes	Yes	Yes	Yes	Yes
Improve Water Quality						
Improved Delta Water Quality	Yes	Yes	Yes	Yes	Yes	Yes
Increased Delta Emergency Response Capability	Yes	Yes	Yes	Yes	Yes	Yes
Increase Recreation						
Recreation (user days, thousands)[7]	85 - 89	116 - 134	201 - 205	307 - 370	246 - 259	142 - 175
Modernization of Recreation Facilities	Yes	Yes	Yes	Yes	Yes	Yes

Notes:

[1] Numbers were derived from SALMOD and represent an index of production increase, based on the estimated average annual increase in juvenile Chinook salmon surviving to migrate downstream from the Red Bluff Pumping Plant.

[2] Average amount per year for 10-year period.

[3] Total drought period reliability for Central Valley Project and State Water Project deliveries. Does not reflect benefits related to water use efficiency actions included in all comprehensive plans.

[4] In addition to increased hydropower generation, all comprehensive plans provide increased capacity benefits (i.e., the rate at which power can be generated) and ancillary services, which provide the ability to manage the electric grid in a reliable manner.

[5] Annual increases in hydropower generation were estimated using two methodologies – at load center (accounting for transmission losses) and at-plant (no transmission losses). To provide a more conservative estimate of potential hydropower benefits, load center generation values were used to estimate potential benefits of increased hydropower generation under comprehensive plans. However, increased generation values reported in Chapter 23, “Power and Energy,” of this Environmental Impact Statement are based on at-plant generation values to capture the largest potential effects from changes in hydropower generation and pumping.

[6] Tributary aquatic enhancement provides for the connectivity of native fish species and other aquatic organisms between Shasta Lake and its tributaries. Estimates of benefits reflect only connectivity with perennial streams and do not reflect additional miles of connectivity with intermittent streams.

[7] Annual recreation visitor user days were estimated using two methodologies. The minimum user day value was used to estimate potential recreation benefits to provide a more conservative estimate of the potential benefits of increased recreation under comprehensive plans. However, the maximum user value was used for direct and indirect effects evaluations in each resource area chapter to capture the largest potential effects from increased visitation. These values do not account for increased visitation due to modernization of recreation facilities associated with all comprehensive plans. For more detailed information related to estimated recreation user days, please see Chapter 10, “Recreational Visitation,” of the Modeling Appendix.

Key:
- = not applicable
CP = comprehensive plan
Delta = Sacramento-San Joaquin Delta
GWh/year = gigawatt-hours per year
NOD = north of Delta
SOD = south of Delta
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre feet

2.6 Preferred Alternative and Rationale for Selection

A plan recommending Federal action should be the plan that best addresses the targeted water resources problems considering public benefits relative to costs. The basis for selecting the recommended plan/preferred alternative is to be fully reported and documented, including the criteria and considerations used in selecting a recommended course of action by the Federal Government. It is recognized that most of the activities pursued by the Federal Government will require assessing trade-offs by decision makers and that in many cases, the final decision will require judgment regarding the appropriate extent of monetized and nonmonetized effects.

The needed rationale to support Federal investment in water resources projects is described in the 2009 CEQ Draft *Proposed National Objectives, Principles, and Standards for Water and Related Resources Implementation Studies (CEQ 2009)*:

> *The presentations shall summarize and explain the decision rationale leading from the identification of need through the recommendation of a specific alternative. This shall include the steps, basic assumptions, analysis methods and results, criteria and results of various screenings and selections of alternatives, peer review proceedings and results, and the supporting reasons for other decisions necessary to execute the planning process. The information shall enable the public to understand the decision rationale, confirm the supporting analyses and findings, and develop their own fully-informed opinions and/or decisions regarding the validity of the study and its recommendations.*
>
> *Opportunities shall be provided for public reaction and input prior to key study decisions, particularly the tentative and final selection of recommended plans. The above information shall be presented in a decision document or documents, and made available to the public in draft and final forms. The document(s) shall demonstrate compliance with the National Environmental Policy Act (NEPA) and other pertinent Federal statutes and authorities.*

NEPA CEQ Regulations require the identification of the alternative or alternatives that are environmentally preferable in the ROD (40 CFR 1505.2(b)). The environmentally preferable alternative generally refers to the alternative that would result in the fewest adverse effects to the biological and physical environment. It is also the alternative that would best protect, preserve, and enhance historic, cultural, and natural resources. Although this environmentally preferable alternative must be identified in the ROD, it need not be selected for implementation. For the purposes of NEPA, an environmentally preferable alternative will be identified in the ROD associated with this EIS.

The preferred alternative has been identified in this Final EIS in consideration of public, stakeholder, and agency comments on this EIS. Ultimately, the alternative that best meets the stated objectives and maximizes net public benefits will be identified with supporting rationale and documentation. The alternative recommended for implementation may or may not be identified as the "Environmentally Preferable Alternative" consistent with NEPA, the "National Economic Development (NED) Plan" consistent with the P&G, the "Least Environmentally Damaging Practicable Alternative" consistent with the CWA, and the "Environmentally Superior Alternative" consistent with CEQA.

Consistent with the above CEQ guidance and NEPA guidelines, the preferred alternative for implementation has been identified for the Final EIS. The preferred alternative and the basis for selecting the preferred alternative can be found in Chapter 32, "Final EIS," Section 32.4, "Preferred Alternative and Rationale for Selection."

This page left blank intentionally.

Chapter 3
Considerations for Describing Affected Environment and Environmental Consequences

3.1 Introduction

Chapters 4 through 25 of this EIS are organized by environmental resource area. Each chapter discusses the affected environment and potential environmental consequences (short- and long-term impacts, direct and indirect impacts, mitigation measures, and cumulative impacts) that could result from implementing the proposed action alternatives.

3.2 Chapter Contents and Definition of Terms

Chapters 4 through 25 are organized into the following resource and issue areas:

- **Chapter 4 –** Geology, Geomorphology, Minerals, and Soils
- **Chapter 5 –** Air Quality and Climate
- **Chapter 6 –** Hydrology, Hydraulics, and Water Management
- **Chapter 7 –** Water Quality
- **Chapter 8 –** Noise and Vibration
- **Chapter 9 –** Hazards and Hazardous Materials and Waste
- **Chapter 10 –** Agriculture and Important Farmland
- **Chapter 11 –** Fisheries and Aquatic Ecosystems
- **Chapter 12 –** Botanical Resources and Wetlands
- **Chapter 13 –** Wildlife Resources
- **Chapter 14 –** Cultural Resources

- **Chapter 15 –** Indian Trust Assets
- **Chapter 16 –** Socioeconomics, Population, and Housing
- **Chapter 17 –** Land Use and Planning
- **Chapter 18 –** Recreation and Public Access
- **Chapter 19 –** Aesthetics and Visual Resources
- **Chapter 20 –** Transportation and Traffic
- **Chapter 21 –** Utilities and Service Systems
- **Chapter 22 –** Public Services
- **Chapter 23 –** Power and Energy
- **Chapter 24 –** Environmental Justice
- **Chapter 25 –** Wild and Scenic River Considerations for McCloud River

For some of these resource and issue areas, there is also an appendix containing a technical report of the same name. The technical reports describe the affected environment in more detail than the summarized information presented in the main body of this EIS. Related modeling results are presented, where appropriate, in the appendices.

3.2.1 NEPA Requirements

Council on Environmental Quality (CEQ) regulations for implementing NEPA include the following requirements for an EIS (Title 40, Code of Federal Regulations (CFR) Section 1502.15):

> *[An] EIS shall succinctly describe the environment of the area(s) to be affected or created by the alternatives under consideration. The descriptions shall be no longer than is necessary to understand the effects of the alternatives. Data and analyses in a statement shall be commensurate with the importance of the impact, with less important material summarized, consolidated, or simply referenced.*

On February 18, 2010, CEQ issued guidance on including greenhouse gas (GHG) emissions and climate change impacts in environmental review documents under NEPA. CEQ guidance suggests that Federal agencies consider opportunities to reduce GHG emissions caused by proposed Federal actions, adapt their actions to climate change impacts throughout the NEPA process, and address these issues in the agencies' NEPA procedures. The following are the two main factors to consider when addressing climate change in environmental documentation:

- Effects of a proposed action and alternative actions on GHG emissions
- Impacts of climate change on a proposed action or alternatives

CEQ notes that "significant" national policy decisions with "substantial" GHG impacts require analysis of their GHG effects. That is, the GHG effects of a Federal agency's proposed action must be analyzed if the action would cause "substantial" annual direct emissions; would implement energy conservation or reduced energy use or GHG emissions; or would promote cleaner, more efficient renewable-energy technologies.

3.2.2 Approach to Affected Environment

Chapters 4 through 25 provide an overview of the existing physical environment and socioeconomic conditions that could be affected by the action alternatives and the No-Action Alternative considered in this EIS. This information was obtained from technical studies prepared by Reclamation for some resource and issue areas; those studies are attached to this EIS. Additional information was obtained from published environmental and planning documents, books, Web sites, journal articles, field surveys, and communications with technical experts. Descriptions of the affected environment are organized by geographic region. Conditions in the primary study area – Shasta Lake and vicinity and the upper Sacramento River (Shasta Dam to Red Bluff) – are described first. These discussions are followed by descriptions of conditions in the extended study area, which consists of the lower Sacramento River and Delta and CVP/SWP facilities and water service areas.

In certain resource areas, the geographic regions are organized slightly differently than how they are defined in Chapter 1, "Introduction." For example, when effects would occur solely because of operational changes, the Trinity, American, and Feather rivers may all be discussed with the extended study area geography for CVP/SWP facilities and service areas, because the impacts would be similar in nature.

3.2.3 Methods and Assumptions

Chapters 4 through 25 analyze the direct and indirect effects of the No-Action Alternative and action alternatives for each environmental resource area. Direct effects are those that would be caused by the action and would occur at the same time and place. Indirect effects are reasonably foreseeable consequences that may occur at a later time or at a distance from the project area. Examples of indirect effects are growth inducement or other effects related to changes in land use patterns, population density, or growth rate, and related effects on the physical environment.

The effects of the No-Action Alternative and action alternatives were determined by comparing estimates of resulting conditions with baseline conditions. These baseline conditions differ between NEPA and CEQA. Under NEPA, the No-Action Alternative (i.e., expected future conditions without the project) is the baseline to which the action alternatives are compared; the No-Action Alternative is also compared to existing conditions. Under CEQA, existing conditions are the baseline to which alternatives are compared.

An environmental document prepared to comply with NEPA must consider the context and intensity of the environmental effects that would be caused by, or result from, the proposed action. Under NEPA, the significance of an effect is a determining factor in whether an EIS must be prepared. An environmental document prepared to comply with CEQA must identify the significance of the environmental effects of a proposed project. As stated in Section 15382 of the State of California (State) CEQA Guidelines, a "[s]significant effect on the environment" means a substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by the project.

The information included in this EIS is based on the best available information. Reclamation, through the scoping process and discussions with agencies and stakeholders, gathered information and performed focused studies to document resource conditions and evaluate the potential impacts of the No-Action and action alternatives. To perform the appropriate level of analysis for an EIS, Reclamation used the best available information on resources and took the requisite hard look at potential impacts of the SLWRI based on the best available technical data. The tools used to evaluate impacts of the alternatives were selected based on Reclamation's standard practices and input from responsible Federal, State, and local agencies and subject matter experts. Interdisciplinary subject matter experts, including engineers, geologists, biologists, cultural resources specialists, architects, and economists, etc., were consulted during the development of the EIS. These experts identified data needed, developed information if data gaps existed, and vetted information through the project team, peer and public review. For a full list of preparers see Chapter 29, "List of Preparers."

CVP and SWP Operational Assumptions

Reclamation and DWR use CalSim-II, a specific application of the Water Resources Integrated Modeling System (WRIMS) to Central Valley water operations, to study operations, benefits, and effects of new facilities and operational parameters for the CVP and SWP. In this EIS, the quantitative assessment of actions related to water resources relied primarily on two CalSim-II baselines for CEQA and NEPA:

- "Existing conditions," based on a 2005 level of development and current facilities, as defined in 2012 (a 2005 baseline)

- "Future conditions," based on without-project forecasted 2020-2030 level of development and reasonably foreseeable future projects and facilities (a 2030 baseline)[1]

Operational assumptions for refinement, modeling, and evaluation of potential effects of the No-Action Alternative and action alternatives included in this EIS were derived from the:

- The Reclamation 2008 Biological Assessment on the Continued Long-Term Operations of the CVP and SWP (2008 Long-Term Operation BA) (Reclamation 2008)

- The USFWS 2008 *Formal ESA Consultation on the Proposed Coordinated Operations of the CVP and SWP* (2008 USFWS Biological Opinion (BO)) (USFWS 2008)

- The NMFS 2009 *BO and Conference Opinion on the Long-Term Operations of the CVP and SWP* (2009 NMFS BO) (NMFS 2009)

- Coordinated Operations Agreement between Reclamation and DWR for the CVP and SWP, as ratified by Congress (Reclamation and DWR 1986)

As Reclamation has advanced the SLWRI, the environmental, hydrologic, and regulatory conditions in the Sacramento River basin and Delta have changed considerably. Among these changes have been substantial declines in the populations of key fish species that use the basin's waterways and the Delta, such as the delta smelt and Chinook salmon. These changes have led to a series of documents and decisions that have affected CVP and SWP operations. The following sections describe the historical decisions related to CVP and SWP operations, the ways in which they have influenced the SLWRI, and the related operational and modeling assumptions for this EIS.

ESA Consultation on CVP and SWP Long Term Operation In June 2004, Reclamation prepared the 2004 Operations Criteria and Plan (OCAP) to provide a description of facilities and the operating environment of the CVP and SWP.

[1] The level of development used for future conditions is a composite of multiple land use scenarios developed by DWR and Reclamation. The Sacramento Valley hydrology, which includes the Sacramento and Feather River basins, is based on projected 2020 land use assumptions associated with DWR Bulletin 160-98 (1998) and the San Joaquin Valley hydrology is based on the 2030 land use assumptions developed by Reclamation. Under any 2020 to 2030 level of development scenario, the majority of the CVP and SWP unmet demand is located south of the Delta, including the San Joaquin Valley. Please see Table 2-1 in the Modeling Appendix for additional information on CalSim-II modeling assumptions.

Using operational information presented in the 2004 OCAP, Reclamation and DWR developed the 2004 OCAP Biological Assessment (BA), prepared as part of the consultation process required by Section 7 of the Federal Endangered Species Act (ESA).

Reclamation consulted with NMFS and USFWS on the 2004 OCAP, and the two agencies issued the 2004 NMFS Biological Opinion (BO) (NMFS 2004) and 2005 USFWS BO (USFWS 2005), respectively. In 2007, the District Court for the Eastern District of California (District Court), in *Natural Resources Defense Council v. Kempthorne*, found the 2005 USFWS BO to be unlawful and inadequate. In May 2008, in *Pacific Coast Federation of Fishermen's Associations v. Gutierrez*, the District Court found the 2004 NMFS BO to be unlawful and inadequate. The District Court remanded both BOs to the agencies.

In 2008, Reclamation provided the USFWS and NMFS the *Biological Assessment on the Continued Long-Term Operations of the CVP and SWP* (2008 Long-Term Operation BA). USFWS and NMFS released their BOs in 2008 and 2009, respectively.

In the 2008 USFWS BO, the USFWS concluded that the long-term operations of the CVP and SWP would jeopardize the continued existence of delta smelt and adversely modify its critical habitat. Consequently, the USFWS developed an RPA to avoid jeopardy.

In the 2009 NMFS BO, NMFS similarly concluded that the long-term operations of the CVP and SWP would jeopardize the continued existence of listed salmonids, steelhead, green sturgeon, and killer whales; it also developed an RPA to avoid jeopardy to the species. The RPA included conditions for revised water operations, habitat restoration and enhancement actions, and fish passage actions. Actions were brought challenging the USFWS and NMFS BOs (2008 and 2009) under ESA and the Administrative Procedure Act (APA), concerning the effects of the CVP and SWP on endangered fish species.

2008 USFWS BO Litigation On December 27, 2010, the District Court entered an "Amended Order on Cross-Motions for Summary Judgment" (Doc. 761), remanding the 2008 USFWS BO to the USFWS without vacatur. On May 4, 2011, the District Court issued an amended Final Judgment, ordering the USFWS to complete a final revised BO by December 1, 2013.

In August 2011, the District Court enjoined implementation of USFWS RPA Component 3 (Action 4), the fall X2 requirements, which require a monthly average position of not greater than 74 km in wet years or 81 km in above normal water years eastward of the Golden Gate Bridge. That injunction is no longer in-effect.

The United States and NRDC appealed the District Court's decision invalidating the 2008 USFWS BO. NRDC also challenged the District Court's finding that Reclamation was required to prepare an EIS on its provisional acceptance of the RPA included in the 2008 USFWS BO. Water user plaintiffs cross-appealed the District Court's opinion. On March 13, 2014, the Ninth Circuit Court of Appeals reversed that part of the District Court's opinion that questioned the validity of the 2008 USFWS BO, but affirmed the District Court's finding that Reclamation violated in NEPA in failing to prepare an EIS on its provisional acceptance of the RPA included in the 2008 USFWS BO.

2009 NMFS BO Litigation In September 2011, the District Court remanded the 2009 BO to NMFS, without vacatur, finding in favor of the Federal government on some counts and in favor of water contractor plaintiffs on other counts. The District Court has ordered NMFS to prepare a draft BO no later than October 1, 2016. To meet that schedule, Reclamation must issue a draft EIS evaluating the environmental impacts associated with implementing the draft NMFS BO by April 1, 2017 (six months after receiving the draft BO), and a final EIS no later than March 28, 2018. Reclamation must prepare an EIS on any RPA included in the draft NMFS BO by February 1, 2018; NMFS must release a final BO by that same date. Reclamation must issue a Record of Decision (ROD), deciding whether to accept the RPA or an alternative, by April 29, 2018. The United States has appealed the District Court's decision, and that appeal is still pending in the Ninth Circuit Court of Appeals.

Summary In February 2013, Reclamation requested reinitiation of ESA Section 7 consultation, to which USFWS and NMFS agreed.

Currently, although the Ninth Circuit Court of Appeals upheld the validity of the 2008 USFWS BO, the USFWS is obligated to issue (or reissue) a BO by December 1, 2015. On that same date, Reclamation must issue a Final EIS analyzing the environmental impacts associated with operating the CVP and SWP under the USFWS BO.

On the NMFS side, NMFS must issue a draft BO to Reclamation no later than October 1, 2016. Reclamation must issue a final EIS no later than February 1, 2018. On that same date, February 1, 2018, NMFS must release a final BO. Reclamation has until April 29, 2018 to issue a ROD.

Operational and Modeling Assumptions for this EIS These legal challenges have resulted in uncertainty with regard to operational constraints for the CVP and SWP. As a result, evaluations of potential effects of the alternatives in the Preliminary DEIS were based on available modeling analysis at that time, which reflected operations described in the 2004 OCAP BA and the Coordinated Operations Agreement between Reclamation and DWR for the CVP and SWP. These analyses were suitable for comparison purposes, and reflected expected variation among the alternatives, including the type and relative magnitude of anticipated impacts and benefits.

In 2012 Reclamation updated the operational assumptions and modeling for the SLWRI to reflect operations described in the 2008 Long-Term Operation BA (as updated due to new facilities, the passage of time, legislation, and litigation), the 2008 USFWS BO, and the 2009 NMFS BO. These assumptions were used to guide refinement, modeling, and evaluation of alternatives and were used as the basis of analysis in the DEIS and this Final EIS. Water operations defined in the RPA were included in existing and future conditions SLWRI modeling evaluations, as described in Table 2-2 of the Modeling Appendix. As described in Table 2-2 of the Modeling Appendix, restoration and enhancement actions and fish passage actions for the Sacramento River and its tributaries were not included in existing or future conditions operations modeling.

Despite the uncertainty resulting from the ongoing consultation process, the 2008 Long-Term Operation BA and the 2008 and 2009 BOs issued by the fishery agencies contain the most recent estimate of potential changes in water operations that could occur in the near future.

3.2.4 Significance Criteria

Significance criteria for each resource area are provided in each resource chapter of this EIS. These criteria are based on the checklist presented in Appendix G of the State CEQA Guidelines; factual or scientific information and data; and regulatory standards of Federal, State, and local agencies. These criteria also encompass the factors taken into account under NEPA to determine the significance of an action in terms of the context and the intensity of its effects.

3.2.5 Impact Comparisons and Definitions

Mechanisms that could cause impacts are discussed for each issue area. General categories of impact mechanisms are construction and activities related to future operation and maintenance, as described in Chapter 2, “Alternatives.” Project-related impacts are categorized as follows, to describe the intensity or duration of the impact:

- A **temporary** impact would last less than 3–4 years and typically would occur only during construction.
- A **short-term** impact could occur during construction and could last from the time construction ceases to within 3–5 years after construction.
- A **long-term** impact would last longer than 5 years after the completion of construction. In some cases, a long-term impact could be a permanent impact.

- A **direct** impact is an impact that would be caused by an action and would occur at the same time and place as the action.

- An **indirect** impact is an impact that would be caused by an action but would occur later in time or at another location, yet is reasonably foreseeable to occur.

- A **cumulative** impact is a project's impact combined with impacts from other past, present, and reasonably foreseeable future projects. A project's incremental impacts are not "cumulatively considerable" solely because other projects would have a significant cumulative impact; rather, the project would also need to contribute considerably to a significant cumulative impact (State CEQA Guidelines, Section 15064(h)(1)).

3.2.6 Impact Levels

The terminology listed below is used to denote the significance of environmental impacts of the No-Action Alternative and action alternatives. This section is intended to allow the use of this EIS for CEQA purposes.

- **No impact** would occur if the construction, operation, and maintenance of the alternative under consideration would not have any direct or indirect effects on the environment. "No impact" means no change from existing conditions. This impact level does not need mitigation.

- An impact that would not result in a substantial and adverse change in the environment would be **less than significant**. This impact level does not require mitigation under CEQA, even if applicable measures are available.

- A **significant** impact is defined by California Public Resources Code (PRC) Section 21068 as "a substantial, or potentially substantial, adverse change in the environment." Levels of significance can vary by project, based on the change in the existing physical condition. This EIS uses the CEQA definition of "significant impact."

- A **potentially significant** impact is one that, if it were to occur, would be considered a significant impact as described above; however, the occurrence of the impact cannot be immediately determined with certainty. For CEQA purposes, a potentially significant impact is treated as if it were a significant impact. Therefore, under CEQA, feasible mitigation measures or alternatives to the proposed action must be identified, where applicable, to reduce the magnitude of potentially significant impacts.

- A **significant and unavoidable** impact is a substantial or potentially substantial adverse effect on the environment that cannot be reduced to a less-than-significant level even with any feasible mitigation. Under CEQA, a project with significant and unavoidable impacts could proceed, but the lead agency would be required to do the following:

  - Conclude in findings that there are no feasible means of substantially lessening or avoiding the significant impact in accordance with Section 15091(a)(3) of the State CEQA Guidelines (i.e., Title 14, California Code of Regulations (CCR) Section 15091(a)(3)).

  - Prepare a statement of overriding considerations, in accordance with Section 15093 of the State CEQA Guidelines, explaining why the lead agency would proceed with a project in spite of the potential for significant impacts.

- A **significant cumulative** impact would occur when the project would make a "cumulatively considerable incremental contribution" to an overall significant cumulative impact. If an overall cumulative impact would not be significant, even when the project would make a cumulatively considerable incremental contribution to the cumulative impact, then it is determined that the project would not cause a significant cumulative impact.

- A **beneficial** impact is a positive change or improvement in the environment, for which no mitigation measures are required.

- An impact may have a level of significance that is too uncertain to be reasonably determined. Such an impact would be designated **too speculative for meaningful evaluation**, in accordance with Section 15145 of the State CEQA Guidelines. Where some degree of evidence points to the reasonable potential for a significant effect, the EIS may explain that a determination of significance is uncertain, but is still assumed to be "potentially significant," as described above. In other circumstances, after thorough investigation, the determination of significance may still be too speculative to be meaningful. This is an effect for which the degree of significance cannot be determined for specific reasons. For example, aspects of the impact itself may be unpredictable or the severity of consequences cannot be known at this time.

3.2.7 Mitigation Development Process and Objectives

Mitigation measures are presented where feasible to avoid, minimize, rectify, reduce, or compensate for significant and potentially significant impacts of the action alternatives, in accordance with Section 15126.4 of the State CEQA

Guidelines and NEPA regulations (Title 40, CFR Section 1508.20). Each mitigation measure is identified numerically to correspond with the number of the impact being mitigated by the measure. No mitigation measures are needed when an impact is determined to be "less than significant" or "beneficial," or where no impact would occur. Where sufficient feasible mitigation is not available to reduce an impact to a less-than-significant level, the impact is identified as "significant and unavoidable."

3.2.8 Significance After Mitigation

For every impact that would be significant or potentially significant, mitigation is applied, if feasible, to avoid or reduce the impact to a less-than-significant level and one of two conclusions is reached:

- The mitigation would reduce the impact to a less-than-significant level.

or

- No feasible mitigation (relevant and reasonable mitigation measures that could be accomplished in a successful manner within a reasonable time period) has been identified to reduce the impact to a less-than-significant level, and thus the impact would be significant and unavoidable.

Impact significance is reevaluated after application of mitigation in this EIS.

3.2.9 Cumulative Effects

This section provides an analysis of overall cumulative effects of the action alternatives and the No-Action Alternative. Cumulative effects are determined by analyzing the potential for project impacts to combine with the impacts of other past, present, and reasonably foreseeable future projects to produce project-related impacts. This analysis follows applicable guidance provided by CEQ in *Considering Cumulative Effects under the National Environmental Policy Act* (CEQ 1997) and *Guidance on the Consideration of Past Actions in Cumulative Effects Analysis* (CEQ 2005).

Definitions of Cumulative Effects

The CEQ regulations that implement NEPA provisions define a cumulative effect as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or nonfederal) or person undertakes such other actions" (Title 40, CFR Section 1508.7).

Cumulative impacts can result from individually minor but collectively significant actions over time, and they differ from indirect impacts (Title 40, CFR Section 1508.8). They are caused by the incremental increase in total environmental effects that occurs when the evaluated project is added to other past, present, and reasonably foreseeable future actions. Cumulative effects can thus arise from causes that are totally unrelated to the project being evaluated, and the analysis of cumulative effects looks at the life cycle of the effects, not the project at issue. These effects can be either adverse or beneficial.

Cumulative impacts are defined in the State CEQA Guidelines (Title 14, CCR Section 15355) as “two or more individual effects which, when considered together, are considerable or which compound or increase other environmental impacts.” A cumulative impact occurs from “the change in the environment which results from the incremental impact of the project when added to other closely related past, present, and reasonably foreseeable future projects. Cumulative impacts can result from individually minor but collectively significant projects taking place over a period of time (Title 14, CCR Section 15355(b)).

Consistent with the State CEQA Guidelines (Title 14, CCR Section 15130(a)), the discussion of cumulative impacts in Chapters 4 through 25 focuses on significant and potentially significant cumulative impacts. The State CEQA Guidelines (Title 14, CCR Section 15130(b)) state that:

> *The discussion of cumulative impacts shall reflect the severity of the impacts and their likelihood of occurrence, but the discussion need not provide as great detail as is provided for the effects attributable to the project alone. The discussion should be guided by the standards of practicality and reasonableness, and should focus on the cumulative impact to which the identified other projects contribute rather than the attributes of other projects which do not contribute to the cumulative impact.*

Effects of Project Implementation with Climate Change

Each resource area evaluates the effects of the action alternatives and No Action Alternative combined with predicted effects of climate change. The ways that the SLWRI could affect GHG production are described in Chapter 5, “Air Quality and Climate.” The Climate Change Modeling Appendix provides a summary of global climate forecasts and a discussion of the implications of climate change for California water resources. This appendix also includes quantitative analyses of climate change for selected comprehensive plans on resource areas. The discussion of climate change implications provided in the Climate Change Modeling Appendix provides context for consideration of cumulative conditions.

Relationship to CALFED Programmatic Cumulative Impacts Analysis

The analysis of cumulative effects in this EIS relies on and tiers to the cumulative effects assessment in the CALFED Bay-Delta Program (CALFED) Programmatic EIS/ Environmental Impact Report (PEIS/R). The “Shasta Lake

Enlargement" project was included in the cumulative impacts analysis of the CALFED PEIS/R as a project in CALFED's Storage Program (CALFED 2000).

This project-specific analysis fully considers and builds upon the analysis of cumulative effects in the CALFED PEIS/R (CALFED 2000). This analysis focuses on issues resulting from the effects of the SLWRI combined with other reasonably foreseeable future projects. This EIS considers CALFED projects that have been implemented, are being implemented, or are reasonably foreseeable future projects. The projects that have been implemented are considered as part of existing conditions; reasonably foreseeable future projects are considered as part of future conditions.

In compliance with Section 1502.20 of the CEQ regulations that implement NEPA, the analysis of cumulative effects tiers to the CALFED Final PEIS/R and the Programmatic ROD issued August 28, 2000. The analysis and assumptions in the CALFED Final PEIS/R and Programmatic ROD are applicable to the SLWRI cumulative analysis. First, the analysis of cumulative impacts in the CALFED Final PEIS/R considered the long-term environmental impacts of the CALFED Preferred Program Alternative and alternatives, including those that would be less than significant, together with similar impacts of other projects. The CALFED Final PEIS/R and Programmatic ROD evaluated, at a programmatic level, five surface water storage projects to be pursued with project specific studies. These studies included Shasta Lake Enlargement, Los Vaqueros Reservoir Enlargement, Sites Reservoir, In-Delta Storage, and development of storage in the upper San Joaquin River Basin. The CALFED PEIS/R analysis of cumulative effects describes the effects of these storage projects with past, present, and reasonably foreseeable projects in the Delta region, Bay region, Sacramento River region, San Joaquin River region, and other SWP and CVP service areas. To that point, storage projects (e.g., Los Vaqueros Reservoir Enlargement) have proceeded as described in the CALFED Final PEIS/R while no other large storage projects have been implemented that were not described in the CALFED analysis. Second, because CALFED actions affected a large geographic area over a 30-year time frame, this analysis of cumulative impacts, growth inducement, and area-wide impacts assessment builds upon the CALFED PEIS/R analysis of cumulative effects to include an updated analysis of reasonably foreseeable projects, recent and relevant BOs, and more specific information about the potential for the action alternatives to cause wide-ranging effects.

Methods and Assumptions

For purposes of this EIS, cumulative impacts of an action alternative would be significant if implementing the alternative would make a considerable incremental contribution to a significant cumulative effect. The alternative's contribution is evaluated in combination with the effects of other past, present, and reasonably foreseeable future projects to determine whether (1) the overall cumulative effect would be significant and (2) the alternative's contribution would be considerable. Cumulatively significant impacts would do any of the following:

- Cause a significant adverse effect on a resource (using the criteria for significance described in the "Environmental Consequences and Mitigation Measures" sections of Chapters 4 through 25 of this EIS)
- Adversely affect a resource that already has a degraded or declining condition because of substantial adverse effects that have already occurred
- Cause effects that initially were not significant, but would be part of an irreversible degrading or declining trend

Following CEQ guidance, Reclamation has identified associated actions (past, present, or future) that, when viewed with the proposed or alternative actions, may have significant cumulative impacts. Table 3-1 lists the plans, projects, and programs that were considered for each resource area.

The State CEQA Guidelines identify two basic methods for establishing the cumulative environment in which the project is to be considered: using a list of past, present, and probable future projects (the "list approach") or using adopted projections from a general plan, other regional planning document, or certified Environmental Impact Report (EIR) for such a planning document (the "plan approach"). For this analysis of cumulative impacts, the list approach and the plan approach have been combined in quantitative and qualitative assessments to generate the most comprehensive future projections possible. The methodology for each of these assessments is described following Table 3-1.

Table 3-1. Present and Reasonably Foreseeable Future Actions Included in the Analysis of Cumulative Impacts, by Resource Area

Cumulative Projects
Quantitative
Forecasted 2030 Level of Demands for Water Supplies
Freeport Regional Water Project
Delta Water Supply Project
DWR South Bay Aqueduct Improvement and Enlargement Project
Vernalis Adaptive Management Plan
San Joaquin River Restoration Program – Full Restoration Flows
Grassland Bypass Project
Qualitative Assessment of Actions Related to Water/ Natural Resource Management and Restoration
Central Valley Project Improvement Act
Refuge Water Supply Program
Clear Creek Actions of the CVPIA Anadromous Fish Restoration Program
CALFED Ecosystem Restoration Program
Qualitative Assessment of Actions Related to the 2009 NMFS Biological Opinion
Clear Creek Actions: Spawning Gravel Augmentation -Spring Creek Temperature Control Curtain -Adaptively Manage to Habitat Suitability/IFIM Study
Fish Passage Program (Action V) at Shasta and Folsom Dams
Sacramento River Basin Salmonid Rearing Habitat Improvements: -Restoration of Floodplain Rearing Habitat -Near Term Actions at Liberty Island/Lower Cache Slough and Lower Yolo Bypass -Lower Putah Creek Enhancements
The Water Quality Control Plan for the California Regional Water Quality Control Board: Central Valley Region, the Sacramento River Basin and San Joaquin River Basin
The California Air Resources Board Climate Change Scoping Plan: A Framework for Change
Bay Delta Conservation Plan
San Joaquin River Restoration Program
Trinity River Mainstem Fishery Restoration Program
Sacramento River Conservation Area Forum Program
Iron Mountain Mine Restoration Plan
Deer Creek Flow Enhancement Program
Lower Deer Creek Falls Fish Passage Improvement Project
Battle Creek Salmon and Steelhead Restoration Project
Butte Regional Conservation Plan
North-of-Delta Offstream Storage Investigation

Table 3-1. Present and Reasonably Foreseeable Future Actions Included in the Analysis of Cumulative Impacts, by Resource Area (contd.)

Cumulative Projects
Qualitative Assessment of Actions Related to Water/ Natural Resource Management and Restoration (contd.)
Fremont Landing Conservation Bank
Yuba Salmon Forum Fish Passage Studies (Upper Yuba River Studies Program)
Davis-Woodland Water Supply Project
North Bay Aqueduct Alternative Intake Project
Lower Clear Creek Anadromous Fish Restoration and Management Project
North Delta Flood Control and Ecosystem Restoration Project
Two-Gates Fish Protection Demonstration Project
Franks Tract Project
Dutch Slough Tidal Marsh Restoration Project
Suisun Marsh Management, Preservation, and Restoration Plan
In-Delta Storage Program (Delta Wetlands Project)
Los Vaqueros Reservoir Expansion Project
East Bay Municipal Utility District Water Supply Management Program 2040
Bay Area Regional Desalination Project
Upper San Joaquin River Basin Storage Investigation (Temperance Flat Reservoir)
San Luis Drainage Reevaluation Program
Central Valley Salinity Alternatives for Long-Term Sustainability Initiative
San Joaquin River Salinity at Vernalis Salt and Boron TMDL and Basin Plan Amendment
B.F. Sisk Dam Corrective Action Project
San Luis Reservoir Low Point Improvement Project
Shasta-Trinity National Forest Land and Resource Management Plan
Mendocino National Forest Land and Resources Management Plan
Qualitative Assessment of Actions Related to Flood Management
Central Valley Flood Protection Plan
CALFED Levee System Integrity Program
Sacramento River Bank Protection Project
Folsom Dam Joint Federal Project
Natomas Levee Improvement Program Landslide Improvement Project
West Sacramento Levee Improvement Program
Delta Islands and Levees Feasibility Study

Table 3-1. Present and Reasonably Foreseeable Future Actions Included in the Analysis of Cumulative Impacts, by Resource Area (contd.)

Cumulative Projects
Qualitative Assessment of Actions Related to Energy
Increased Hydropower Generation Capacity at Lewiston Dam
Pacific Gas & Electric Company Pit River 3, 4 & 5 Hydroelectric Projects License Implementation
Pacific Gas & Electric Company McCloud and Pit Rivers 6 and 7 FERC Relicensing
California Department of Water Resources Oroville Facilities FERC Relicensing
Sacramento Municipal Utility District Upper American River Project
Qualitative Assessment of Actions Related to Land Use Planning and Infrastructure
Antlers Bridge Replacement
Jellys Ferry Bridge Replacement
Moody Flats Quarry
Mountain Gate at Shasta Mixed-Use Area Plan

Key:
CALFED = CALFED Bay-Delta Program
CVPIA = Central Valley Project Improvement Act
DWR = California Department of Water Resources
FERC = Federal Energy Regulatory Commission
IFIM = Instream Flow Incremental Methodology
NMFS = National Marine Fisheries Service
TMDL = total maximum daily load

Quantitative Assessments Quantitative assessments were completed for each of the resource areas in this EIS, where feasible. The effects of actions related to water resources and effects of development projects were assessed quantitatively. Numerical changes to water resources and air quality were considered qualitatively in the consideration of cumulative impacts on related resources. The methodologies for the quantitative assessments are described below.

Quantitative Assessment of Actions Related to Water Resources In this EIS, the quantitative assessment of actions related to water resources relied primarily on CalSim-II modeling of hydrologic conditions that could affect the environment. The model was run using two different baselines:

- "Existing conditions," based on 2005 a level of development and current facilities, as defined in 2012 (a 2005 baseline)
- "Future conditions," based on without-project forecasted 2020-2030 level of development and reasonably foreseeable future projects and facilities (a 2030 baseline)[2]

The 2030 baseline does not account for potential changes in water demands resulting from the effects of climate change. Potential changes in water demand due to climate change are described qualitatively in the "Qualitative Assessments" section. The 2030 baseline includes the following reasonably foreseeable future projects and conditions, described separately below:

- Forecasted 2030 level of demands for water supplies
- Freeport Regional Water Project
- Delta Water Supply Project
- DWR South Bay Aqueduct Improvement and Enlargement Project
- Vernalis Adaptive Management Plan (VAMP) (as a representation of future San Joaquin River flow objectives)
- San Joaquin River Restoration Program (SJRRP) – Full Restoration Flows

[2] The level of development used for future conditions is a composite of multiple land use scenarios developed by DWR and Reclamation. The Sacramento Valley hydrology, which includes the Sacramento and Feather River basins, is based on projected 2020 land use assumptions associated with DWR Bulletin 160-98 (1998) and the San Joaquin Valley hydrology is based on the 2030 land use assumptions developed by Reclamation. Under any 2020 to 2030 level of development scenario, the majority of the CVP and SWP unmet demand is located south of the Delta, including the San Joaquin Valley. Please see Table 2-1 in the Modeling Appendix for additional information on CalSim-II modeling assumptions.

- Grassland Bypass Project

Forecasted 2030 Level of Demands for Water Supplies Reclamation and DWR developed assumptions for evaluating systemwide hydrologic and water supply conditions with CalSim-II under existing and future conditions. Detailed descriptions of the CalSim-II model, the modeling methodology used in evaluations, and key assumptions (including forecasted 2030 facilities and demands) are provided in the Modeling Appendix. For a summary of the analysis and modeling results, see the Hydrology, Hydraulics, and Water Management Technical Report (in the Physical Resources Appendix).

To quantify cumulative effects on hydrologic conditions, modeling runs with No-Action Alternative (2030) conditions were compared to modeling runs with existing (2005) conditions. For example, the No-Action Alternative (2030 baseline) was compared to existing conditions (2005 baseline) to identify the cumulative impacts of reasonably foreseeable future projects and conditions on hydrologic conditions. The impacts of action alternatives were added to cumulative impacts of reasonably foreseeable future projects and conditions (No-Action Alternative) to identify the combined cumulative effects. The No-Action Alternative (2030) includes forecasted year-2030 demands for water. These forecasted demands are considered to be reasonably foreseeable for determining cumulative impacts.

Freeport Regional Water Project The Freeport Regional Water Project is intended to provide water for East Bay Municipal Utility District (EBMUD) customers in dry years and needed water for the Sacramento region by drawing water from the Sacramento River near the town of Freeport. Construction was completed in 2011 and project operations have been coming online incrementally since 2012. The project consists of a new 185-million-gallon-per-day water intake structure and pumping plant on the Sacramento River, a new large-diameter pipeline to transport water eastward from the intake to a new Sacramento County Water Agency water treatment plant and to the existing Folsom South Canal. The Freeport Regional Water Project is included only in future conditions for the SLWRI.

Delta Water Supply Project The Delta Water Supply Project provides a new supplemental high-quality water supply for the Stockton metropolitan area. The project, once completed, is intended to replace declining surface water resources, protect groundwater supplies, and provide for current and future water needs in the Stockton metropolitan area. Construction for Phase 1 of this project was completed in 2012, and associated project facilities are currently in use. The project includes a new intake and pump station that will divert water from the San Joaquin River through miles of underground pipeline to a new 30-million-gallon-per-day water treatment plant. The project will help meet Stockton's water needs, as detailed in the City of Stockton's general plan, through 2025. The Delta Water Supply Project is included only in future conditions for the SLWRI.

DWR South Bay Aqueduct Improvement and Enlargement Project The South Bay Aqueduct conveys water from the Delta through more than 40 miles of pipelines and canals to the Zone 7 Water Agency and the Alameda County and Santa Clara Valley water districts. Those three water districts, in turn, serve the cities of Livermore, Dublin, Pleasanton, San Ramon, Fremont, Newark, Union City, Milpitas, Santa Clara, and San Jose, among others.

The first conveyance facility constructed for the SWP, the South Bay Aqueduct, was designed for a capacity of 300 cubic feet per second (cfs). Recent flow tests and studies have shown that the actual capacity is 270 cfs. The purpose of the South Bay Aqueduct Enlargement Project is to increase the aqueduct's capacity to 430 cfs to meet the Zone 7 Water Agency's future needs and provide operational flexibility to reduce the SWP's peak power consumption.

The following are the principal features of this project:

- Add four 45 cfs pumps to the South Bay Pumping Plant, and expand the existing plant structure and add a new service bay and switchyard.
- Construct a third (Stage 3) Brushy Creek pipeline and surge tank parallel to the existing two barrels.
- Construct a 500-acre-foot reservoir (425 acre-feet of active storage) to be served by the Stage 3 Brushy Creek Pipeline.
- Raise the height of the canal embankments, canal lining, and canal overcrossing structures and bridges along the Dyer, Livermore, and Alameda canals and at the Patterson Reservoir.
- Modify check structures and siphons along the Dyer, Livermore, and Alameda canals.
- Construct new drainage overcrossing structures to eliminate drainage into the canals.

Construction is proceeding on enlargement of the South Bay Pumping Plant to make room for the four new pump units (DWR 2011a). The South Bay Aqueduct Improvement and Enlargement Project is included only in future conditions for the SLWRI.

Vernalis Adaptive Management Plan The VAMP was a 12-year experimental management program proposed under the 1998 San Joaquin River Agreement (SJRA), which was adopted by the State Water Resources Control Board (State Water Board) in Water Right Decision 1641 (December 1999). Although VAMP expired in 2011, VAMP requirements are included in SLWRI modeling to represent interim actions and likely future State Water Board objectives for San Joaquin River flows at Vernalis.

VAMP was initiated to protect juvenile Chinook salmon emigrating through the San Joaquin River and Delta, and to evaluate how Chinook salmon survival rates change in response to alterations in San Joaquin River flows and exports at CVP and SWP facilities in the south Delta when the Head of Old River Barrier is installed. A water acquisition program for instream flows and a monitoring program for VAMP were implemented through the SJRA, which was adopted in 2000 and twice extended, finally expiring in December 2011. Signatories to the SJRA included Reclamation, DWR, CDFW, USFWS, San Joaquin River Group Authority and member agencies, Exchange Contractors, and select CVP and SWP Contractors, San Francisco Public Utilities Commission, and several environmental interest groups.

VAMP provided guidance for flows in the lower San Joaquin River during a 31-day pulse-flow period during April and May. The predicted April 15 San Joaquin River flows at Vernalis were increased by 1 to 2 predefined “steps,” ranging from 1,200 cfs to 1,300 cfs between each step, depending on the average of water-year conditions for the current year and the previous year. For more information on VAMP flows, see the expiration of VAMP in 2011 introduced uncertainty regarding responsibility for meeting San Joaquin River flow standards set forth in the 1995 Bay Delta Plan until new San Joaquin River flow standards are identified. In the interim (2012 and 2013), Reclamation implemented a “single-step” VAMP, in which flows were increased by only one step in all water year types. Single-step VAMP operations are reflected in the SLWRI’s modeling of existing conditions.

It is anticipated that future State Water Board objectives will be as protective as the original VAMP requirements and will remain in place through 2030. Additionally, the 2009 NMFS BO RPAs include requirements for a continuation of VAMP-like flow objectives. It specifies minimum flow requirements in the San Joaquin River at Vernalis and restricts CVP and SWP export pumping amounts and ratios dependent on San Joaquin River flow at Vernalis. Accordingly, the SLWRI’s modeling of future conditions has incorporated full VAMP flow requirements.

San Joaquin River Restoration Program – Full Restoration Flows   The SJRRP was established in 2006 to implement the Stipulation of Settlement in *NRDC, et al., v. Kirk Rodgers, et al.* (Settlement). (See also the discussion of the SJRRP in “Qualitative Assessment of Actions Related to Water Resources,” later in this chapter.) Federal authorization for implementing the Settlement is provided in the San Joaquin River Restoration Settlement Act, included in Public Law 111-11.

The Settlement calls for releases of water from Friant Dam to the confluence of the Merced River, referred to as Interim and Restoration flows; a combination of channel-related and structural modifications along the San Joaquin River below Friant Dam; and reintroduction of Chinook salmon. Restoration Flows are specific volumes of water to be released from Friant Dam during different year types, according to Exhibit B of the Settlement. Interim Flows were experimental flows that were implemented from 2009 until Restoration Flows were implemented in 2014. Interim Flows allowed the SJRRP to collect relevant data about flows, temperatures, fish needs, seepage losses, recirculation, recapture, and reuse.

The release of Interim Flows began in October 2009; however, the release of Interim Flows was limited by channel capacity constraints between Friant Dam and the Merced River confluence. The release of Restoration Flows began on January 1, 2014, but is currently restricted due to capacity constraints. Full Restoration Flows are intended to include annual releases from Friant Dam of up to 840,000 acre-feet, depending on year type. In some years, peak releases from Friant Dam could reach as much as 8,000 cfs for several hours, within the constraints of channel capacity. For the SLWRI, existing conditions include Interim Flows and future conditions include full Restoration Flows.

Grassland Bypass Project The Grassland Bypass Project is a stakeholder initiative designed to improve water quality in the channels used to deliver water to the San Joaquin River and wetland areas in the Grassland watershed. Irrigation of soils containing high levels of salt and selenium has caused high levels of selenium to leach into the subsurface drainage water in the 97,000-acre Grassland Drainage Area. Before the Grassland Bypass Project began, this agricultural drainage water ultimately discharged into the San Joaquin River through Salt Slough, Mud Slough, and other channels used to deliver water to wetland areas in the Grassland watershed. The San Joaquin River is included on the Federal Clean Water Act (CWA) Section 303(d) list of impaired waters as impaired for 18 different pollutants, with total maximum daily load (TMDL) set for 6 of these pollutants within the watershed (selenium, dissolved oxygen, diazinon, chlorpyrifos, salt, and boron). Approximately 8,200 acres of Grasslands watershed marshes, a portion of the lower San Joaquin River (from the confluence with Mud Slough to the Merced River confluence), and Mud Slough are listed on the CWA Section 303(d) list of impaired waters for exceeding water quality objectives for selenium.

The Grassland Bypass Project has been implementing agricultural best management practices and measures to reroute drainage water to reduce total selenium loading to impaired waters. The objectives of the project have been to achieve short-term load reductions by 2010 (partial implementation) and to prohibit all discharges exceeding selenium objectives by 2019 (full implementation). Between 1998 and 2009, best management practices implemented by Grassland area farmers prevented the discharge of more than 22,000 pounds of selenium to listed waters. As a result, Salt Slough and a portion of the lower San Joaquin River have been removed from the 303(d) list of impaired waters. In 2012, the volume of agricultural drainage water discharged from the Grassland Drainage Area into the San Luis Drain was reduced by 12,000 acre-feet through displacement across the San Joaquin River Water Quality Improvement Project reuse area.

For the SLWRI, the water operations models for existing conditions and future conditions include partial implementation and full implementation, respectively, of the Grassland Bypass Project.

Quantitative Assessment of Effects on Air Quality For this analysis of cumulative impacts, regional impacts on air quality are analyzed quantitatively using the plan approach. As described in Chapter 5, "Air Quality and Climate," significance thresholds for the Shasta County Air Quality Management District (SCAQMD) are defined in the *Shasta County General Plan* (SCAQMD 2004). The analysis of local cumulative impacts is based on both the plan approach, which defines impact thresholds, and the list approach, which identifies projects that may emit pollutants in the same area as the SLWRI. SCAQMD standards for criteria pollutants have been established to limit the emissions of individual projects when considering the cumulative effect of all projects on regional pollutant concentrations. Therefore, a significant direct project impact would also be a cumulatively considerable incremental contribution to a significant cumulative impact.

The 2007 Urban Emissions model (URBEMIS) was used to estimate emissions of pollutants from construction activities. Among the inputs to the model for construction analysis were the types and quantities of construction equipment to be used, along with the hours of use; areas of land to be graded; number of truck trips and trip distances for export of spoils and import of materials; volumes of buildings to be demolished; areas of buildings to be built; and areas of land to be paved. For postconstruction activities, the principal inputs were the number of vehicle trips and average trip distances. The methods and results of this analysis are described in greater detail in Chapter 5, "Air Quality and Climate."

Qualitative Assessments Past, present, and reasonably foreseeable future actions were assessed qualitatively. Information on current and historical conditions was used to evaluate the combined effects of past actions on resource areas and issues. For present and reasonably foreseeable future actions, a list of related actions was compiled. The combined effects of past, present, and reasonably foreseeable future actions were then evaluated with effects of the project.

A large number of past actions have occurred in the study area. These past actions have strongly influenced existing conditions, and some past actions created "legacies" that are still affecting resources. Among the legacies is the sediment released by hydraulic mining and the metal contamination that is still being generated by abandoned mines. The following are the most important combined effects of these past actions:

- Population growth and associated development of socioeconomic resources and infrastructure

- Conversion of natural vegetation to agricultural and developed land uses
- Introduction of nonnative plant and animal species
- Resource extraction (e.g., mining, grazing, and timber harvests)
- Development of water supply, particularly the construction and operation of Shasta Dam, the rest of the CVP, and the SWP

Present projects and reasonably foreseeable future projects include projects that are currently under construction, approved for construction, or in the final stages of formal planning. The present and reasonably foreseeable future actions considered in this analysis of cumulative impacts are those actions located within the primary or extended study area that have been identified as potentially affecting resources that also may be affected by the SLWRI.

A preliminary list of actions was compiled by reviewing available information regarding planned projects (including agency Web sites). Actions were then reviewed for inclusion in the cumulative impacts analysis based on this criteria:

- The action has an identified sponsor actively pursuing project development; the sponsor has completed or issued NEPA and/or CEQA compliance documents such as a DEIS or Draft EIR (DEIR); and the action appears to be “reasonably foreseeable,” given other considerations such as public and stakeholder controversy.
- Available information defines the action in sufficient detail to allow meaningful analysis.
- The action could affect resources that could be potentially affected by the project.
- Any action that could affect resources that would be potentially affected by the project and is under construction was also considered “reasonably foreseeable.”

Based on this review, the effects of the actions described below were considered qualitatively in the assessment of cumulative effects of action alternatives. This list is organized into four categories of actions: water resources, resource management and restoration, levee, and development actions. Some unknown subset of the following projects, though not strictly meeting the criteria above, would likely be implemented, such as the Bay Delta Conservation Plan (BDCP), the North-of-Delta Offstream Storage Facility (Sites Reservoir), and the Upper San Joaquin River Basin Storage Investigation (Temperance Flat Reservoir). For example, the BDCP DEIR/DEIS (DEIR/S), which was released in December 2013, evaluates 15 action alternatives, including a No-Action alternative, and a range of 20 potential conservation measures; a BDCP preferred alternative was not identified in the 2013 BDCP DEIR/S. In August 2014, it was announced that a partially Recirculated Draft BDCP, EIR/S, and Implementing Agreement will be published in early 2015; it is unknown if a preferred alternative will be identified in the BDCP 2015 Recirculated DEIR/S. Therefore, the selection of any one alternative is speculative at this point in time. It would be speculative to consider these projects at any more than a conceptual level because these projects and their effects are not defined in sufficient detail to allow meaningful analysis.

The combined effects of past actions and the list of related present and reasonably foreseeable future projects are described further below.

Qualitative Assessment of Actions Related to Water/Natural Resource Management and Restoration In addition to the water resources actions described above in the section “Quantitative Assessment of Actions Related to Water Resources,” the water/natural resources-related management and restoration actions described below were identified as present or reasonably foreseeable.

Central Valley Project Improvement Act The CVPIA (Title 34, Sections 3401 through 3408(h) of Public Law 102-575) is concerned with restoring anadromous fish populations, providing water supplies for Federal and State refuges, mitigating effects of the CVP on other fish and wildlife, and retiring drainage-impaired farmlands. To fulfill these provisions, the CVPIA established an ongoing program creating a fund for restoration actions. The program is financed by the CVP’s water and power users and administered by Reclamation. Funds are contributed to multiple restoration actions annually to finance restoration of aquatic, riparian, and other habitats and modify CVP operations.

The CVPIA directs the Secretary of the Interior to develop and implement a program that makes all reasonable efforts to double natural production of anadromous fish in Central Valley streams (Section 3406(b)(1)). The general objectives of the CVPIA Anadromous Fish Restoration Program are as follows:

- Improve anadromous fish habitat through physical habitat parameters as well as suitable flow parameters.
- Reduce the entrainment of juvenile fish at diversions.
- Collect fisheries data in a way that provides for the evaluation of restoration actions.
- Integrate restoration efforts with harvest and hatchery management.
- Involve stakeholders in the implementation and evaluation of restoration actions.

The Clear Creek Actions of the CVPIA Anadromous Fish Restoration Program involve modifying flow releases and replenishing gravels in the river downstream from Whiskeytown Dam to enhance spawning, egg incubation, and emigration by spring-, fall-, and late fall-run Chinook salmon. These actions also include gravel restoration, spring flushing, temperature control, and channel maintenance. Additionally, requirements of the Clear Creek Actions – all implemented to benefit anadromous fish habitat – include restoring habitat damaged by gravel mining in the area, decommissioning McCormick-Saeltzer Dam, developing a stream corridor protection program to prevent habitat degradation caused by sedimentation and urbanization, and developing a watershed management and analysis plan.

CVPIA Section 3406. Fish, Wildlife, and Habitat Restoration CVPIA Section 3406 (d) states that "…the Secretary [of the Interior] shall provide, either directly or through contractual agreements with other appropriate parties, firm water supplies of suitable quality to maintain and improve wetland habitat areas on units of the National Wildlife Refuge System in the Central Valley of California; on the Gray Lodge, Los Banos, Volta, North Grasslands, and Mendota state wildlife management areas; and on the Grasslands Resources Conservation District in the Central Valley of California."

Refuge Water Supply Program The goal of the Refuge Water Supply Program (RWSP), which consists of three important components – water acquisitions, conveyance, and facilities' construction, is to ensure that all CVPIA-identified wetland habitat areas (refuges), annually receive water of specified quantity, of suitable flow rate and timing, and suitable quality to support their wetland and aquatic environments. The RWSP serves 19 refuges in the Central Valley.

The RWSP is administered and implemented by Reclamation in close collaboration with the USFWS, Region 8. Reclamation and the USFWS also work cooperatively with the California Department of Fish & Wildlife (CDFW), Grassland Water District (GWD), and the Central Valley Habitat Joint Venture (CVHJV) in implementing the RWSP.

The RWSP delivers two water types defined as Level 2 (L2) water and Incremental Level 4 (IL4) water:

- L2 is the amount of water required for minimum wetlands and wildlife habitat management based on historic average annual deliveries before 1989. Reclamation is required to provide full L2 water supplies annually. The L2 annual water delivery target is 422,251 acre-feet, including 26,007 acre-feet of replacement water. Replacement water was originally provided by tailwater and groundwater but is now included in L2 water supplies due to water quality concerns.

- IL4 water is the difference between L2 and Full Level 4 (L4) water supplies; it equals 133,264 acre-feet.

Full L4 is the total annual amount of water identified for each refuge in CVPIA as required for optimum wetlands and wildlife habitat development and management. The Full L4 water delivery target for the 19 refuges is 555,515 acre-feet and is met when L2 and IL4 water targets are met in full.

The CVPIA specifies that Reclamation must acquire IL 4 water "…through voluntary measures such as water conservation, conjunctive use, purchase, lease, donations, or similar activities, or a combination of such activities which do not require involuntary reallocations of project yield" (CVPIA, Section 3406 (d)(2)). The amount of IL4 water acquired varies from year to year, depending on annual hydrology, water availability, water market pricing, and funding.

To ensure reliability for refuge managers, Reclamation entered into long-term water supply contracts with the three refuge managers: CDFW, USFWS, and GWD. These contracts have performance periods of 25 years and are renewable, representing Reclamation's obligation under CVPIA to provide identified quantities of water to certain refuges in the Central Valley.

From Fiscal Year 2002 – 2013, the RWSP has delivered an annual average of 383,603 acre-feet of L2 water (91 percent of the 422,251 acre-feet target) and 66,588 acre-feet of IL4 water (50 percent of the 133,264 acre-feet target) (Reclamation 2014). Fiscal Year 2002 was the first year that CVPIA mandated Full L4 deliveries for all refuges (CVPIA Section 3406 (d)(2)).

American Basin Fish Screen and Habitat Improvement Project The American Basin Fish Screen and Habitat Improvement Project is a river intake facility, including the fish screen, 434 cfs pumping plant, access bridges, canal connection, irrigation canal, connections to existing canals, and hibernacula and wetlands plantings on and near the Sacramento River completed by the Natomas Central Mutual Water Company as part of CVPIA 3406(b)(21).

CALFED Ecosystem Restoration Program USFWS and NMFS implement CALFED's Ecosystem Restoration Program (ERP) with guidance from the Delta Stewardship Council and the Delta Plan, and in coordination with the Sacramento-San Joaquin Delta Conservancy. The ERP works to improve the ecological health of the San Francisco Bay/Sacramento-San Joaquin Delta (Bay-Delta) watershed by restoring and protecting habitats, ecosystem functions, and native species. Since the program's inception, ERP agencies have identified more than 600 programmatic actions and 119 milestones throughout the Bay-Delta watershed. The program includes all projects authorized, funded, and permitted (even if not constructed) to date, particularly in the Delta, that aim to do any of the following:

- Recover at-risk native species dependent on the Delta, Suisun Bay, and San Francisco Bay
- Minimize the downward population trends of native species that are not listed
- Protect and restore functional habitat types in the Bay-Delta estuary and its watershed for ecological and public values
- Prevent the establishment of additional nonnative invasive species and reduce the negative ecological and economic impacts of established nonnative species in the Bay-Delta estuary
- Improve and/or maintain water and sediment quality conditions that fully support healthy and diverse aquatic ecosystems in the Bay-Delta estuary and watershed

2009 NMFS Biological Opinion Sacramento River Habitat Restoration and Enhancement and Fish Passage Actions The 2009 NMFS BO included RPAs to improve conditions for anadromous fish in the Sacramento River basin. These RPAs included revised water operations, habitat restoration and enhancement actions, and fish passage actions. Water operations defined in RPAs were included, as appropriate, in the modeling evaluations for both existing and future conditions, and therefore were included in cumulative effects analyses. However, the following restoration and enhancement actions and fish passage actions for the Sacramento River and its tributaries were not included in existing or future conditions operations modeling. The actions related to the 2009 NMFS BO described below were identified as present or reasonably foreseeable actions.

Clear Creek Actions Certain Clear Creek RPAs were designed to prevent spring-run Chinook salmon from hybridizing with fall-run Chinook salmon in the Sacramento River. To prevent this hybridization, the following projects have been developed to attract early spring-run adults far upstream in Clear Creek where reservoir holding has maintained cooler water temperatures throughout the summer:

- **Spawning Gravel Augmentation –** This effort includes the continued augmentation of spawning gravels in Clear Creek to enhance spawning habitat for fall-run, late fall-run, and spring-run Chinook salmon as well as steelhead.
- **Spring Creek Temperature Control Curtain –** This project is the replacement of the Spring Creek Temperature Control Curtain in Whiskeytown Lake, in an effort to maintain the Spring Creek Tunnel's releases of cold water to Keswick Reservoir for winter-run Chinook salmon spawning and incubation.

- **Adaptively Manage to Habitat Suitability/Instream Flow Incremental Methodology Study Results –** This action is to develop a state-of-the-art scientific analysis of habitat suitability to enable the continuation of flows adequate for anadromous fish migration and the maintenance of spawning gravels and suitable water temperatures for anadromous fish survival.

Fish Passage Program (Action V) at Shasta and Folsom Dams The elements identified in the Fish Passage Program are near-term and long-term goals to provide passage for Sacramento River winter-run, spring-run, and Central Valley steelhead above Shasta and Folsom dams. Substantial areas of high-quality habitat exist above these dams, with colder water in high-elevation areas that represents a suitable refuge for cold-water fish in the face of climate change. The assessment will develop information necessary for consideration and development of fish passage options for the Basalt and Porous Lava Groups of Central Valley steelhead and spring-run Chinook salmon and Sacramento River winter-run Chinook salmon.

<u>Sacramento River Basin Salmonid Rearing Habitat Improvements</u>
This suite of actions consists of near-term and long-term actions to restore floodplain rearing habitat for juvenile winter-run, spring-run, and Central Valley steelhead in the lower Sacramento River basin. These actions are consistent with Reclamation's broad authorities in the CVPIA. The objective may be achieved at the Yolo Bypass, as part of the BDCP, or among other actions. The following actions in this suite were not included in modeling analyses for existing conditions, the No-Action Alternative, and action alternatives:

- **Restoration of Floodplain Rearing Habitat –** The intent of this action is to restore floodplain rearing habitat for juvenile winter-run, spring-run, and Central Valley steelhead through a substantial increase in acreage of seasonal floodplain rearing habitat.

- **Near-Term Actions at Liberty Island/Lower Cache Slough and Lower Yolo Bypass –** These actions include the steps necessary to enhance the use of Liberty Island/Lower Cache Slough by juvenile salmonids.

- **Lower Putah Creek Enhancements –** These enhancements, to be completed by the end of 2015, include stream realignment and floodplain restoration for fish passage improvement and multispecies habitat development on existing public lands.

Reduction of Migratory Delays and Loss of Salmon, Steelhead, and Sturgeon at Fremont Weir and Other Structures in the Yolo Bypass Actions
This action involves the completion of planning-related and physical modifications that will provide high-quality, reliable migratory passage through

the Yolo Bypass for Sacramento River basin adult and juvenile anadromous fishes. These actions may include steps to provide fish passage by altering Fremont Weir and/or other facility-related or operational requirements of the Sacramento River Flood Control Project or Yolo Bypass facility.

The Water Quality Control Plan for the California Regional Water Quality Control Board: Central Valley Region, the Sacramento River Basin and San Joaquin River Basin The preparation and adoption of water quality control plans (basin plans) is required by the California Water Code (Section 13240) and supported by the Federal CWA. State law also requires that basin plans conform to the policies set forth in the California Water Code, beginning with Section 13000, and any State policy for water quality control. Because beneficial uses, together with their corresponding water quality objectives, can be defined per Federal regulations as water quality standards, the basin plans are regulatory references for meeting the State and Federal requirements for water quality control (Title 40, CFR Section 131.20). The *Water Quality Control Plan for the California Regional Water Quality Control Board: Central Valley Region, the Sacramento River Basin and San Joaquin River Basin* (Basin Plan) covers the entire Sacramento and San Joaquin River basins. The Basin Plan was first adopted in 1975. In 1989, a second edition was published. The third edition, published in 1994, incorporated all amendments approved between 1989 and 1994, included new State policies and programs, edited and restructured the Basin Plan to make it consistent with other regional and State plans, and substantively amended sections dealing with beneficial uses, objectives, and implementation programs. The Basin Plan was last revised in October 2011 (CVRWQCB 2011).

The California Air Resources Board Climate Change Scoping Plan: A Framework for Change The Global Warming Solutions Act of 2006 (Assembly Bill 32) required the California Air Resources Board to prepare a scoping plan to achieve reductions in California's GHG emissions. The scoping plan was originally approved in 2008. In 2011, the Functional Equivalent Document for the scoping plan was amended. The scoping plan, including the final supplement to the Functional Equivalent Document, was reapproved by the California Air Resources Board on August 24, 2011. The scoping plan provides the outline for actions to reduce California's GHG emissions (ARB 2008).

Bay Delta Conservation Plan The BDCP is a long-term multiple purpose plan that consists of a Habitat Conservation Plan and a Natural Community Conservation Plan. DWR is currently developing the BDCP in application for take permits from USFWS and NMFS for Federally listed species in the Delta. The BDCP would also allow for the authorization of take from the CDFW for species covered in the BDCP, including species protected by State law. The BDCP consists of a comprehensive conservation strategy for the Delta that includes conservation measures for new SWP water conveyance facilities combined with adaptive water conveyance operations; conservation, protection, restoration, and enhancement of habitats for native fish, wildlife, and plants in the Delta; and actions related to reducing other stressors on the Bay-Delta ecosystem. The BDCP conservation measures are specific actions that would be implemented to achieve the biological goals and objectives of the proposed plan. The conservation measures and effects assessment related to achieving the BDCP's overall planning goals are incorporated by reference into the December 2013 BDCP DEIR/S (DWR 2013). The BDCP conservation strategy consists of multiple components that are designed to collectively achieve the overall BDCP planning goals of ecosystem health and water supply reliability. The conservation strategy includes biological goals and objectives, conservation measures, avoidance and minimization measures, and monitoring, research, and adaptive management programs. The BDCP would also provide the basis for future Section 7 consultation between Reclamation, USFWS and NMFS over future operations of the CVP.

Four broad concepts have been studied to address urban water quality, water supply reliability, and environmental concerns in the Delta: physical barriers, hydraulic barriers, through-Delta facilities, and isolated facilities. Several alternative Delta conveyance facilities are being evaluated as part of the plan. Depending on the alternative, the water conveyance facility components would create a new conveyance mechanism to divert water from the north Delta to existing SWP and CVP export facilities in the south Delta, interacting with operational guidelines to achieve the planning goal outlined above.

The Draft BDCP and BDCP DEIR/S were made available to the public for a review and comment period, effective December 13, 2013 through July 29, 2014. On August 27, 2014 it was announced that a partially Recirculated Draft BDCP, EIR/S, and Implementing Agreement will be published in early 2015. The recirculated documents will include those portions of each document that warrant another public review before publication of final documents.

Trinity River Mainstem Fishery Restoration Program The Trinity River Mainstem Fishery Restoration Program is located in the CVP service area at Lewiston Dam on the Trinity River. This program is designed to benefit anadromous salmonids and their habitat by developing a properly functioning, diverse floodplain and riverine habitat. The program's plan has two restoration goals: reestablish the natural physical processes that create and maintain high-quality aquatic habitat; and create spawning and rearing conditions downstream from the dams, including adequate water temperatures to best compensate for lost habitat upstream.

The plan includes direct in-channel actions, continued watershed restoration activities, replacement of bridges and structures within the floodplain, and a program to monitor and improve restoration activities. Some of the actions and activities have been implemented and are operational. The pending phases of the projects incorporated into the DEIR encompass work at 29 rehabilitation sites in Trinity County along the 40-mile reach of the mainstem Trinity River from Lewiston Dam to the North Fork Trinity River. The remaining six Phase 1 sites are concentrated between Lewiston and Douglas City (about a 16-mile reach) and the 23 Phase 2 sites are located between Rush Creek and the North Fork Trinity River near Helena, California.

San Joaquin River Restoration Program As described previously (see the discussion of full SJRRP Restoration Flows in "Quantitative Assessment of Actions Related to Water Resources," above), the SJRRP was established based on the 2006 Settlement of the *Natural Resources Defense Council et al., v. Rodgers, et al.* lawsuit. The SJRRP will restore and maintain fish populations in "good condition" in the mainstem San Joaquin River below Friant Dam to the confluence of the Merced River, including naturally reproducing and self-sustaining populations of salmon and other fish; and reduce or avoid adverse water supply impacts on all of the Friant Division long-term contractors that may result from the Interim Flows and Restoration Flows provided for in the Settlement.

The Settlement followed an 18-year lawsuit that involved the U.S. Departments of the Interior and Commerce, the Natural Resources Defense Council, and the Friant Water Users Authority. The Settlement received Federal court approval in October 2006. Federal legislation was passed in March 2009 authorizing Federal agencies to implement the Settlement. The SJRRP consists of releases of water from Friant Dam to the confluence of the Merced River (Interim and Restoration flows), a combination of channel and structural modifications along the San Joaquin River below Friant Dam, and reintroduction of Chinook salmon (Reclamation and DWR 2012). The SJRRP's channel and structural modifications include modifications to channel and flow-control structures and habitat along the San Joaquin River and Lower San Joaquin Flood Control Project between Friant Dam and the Merced River confluence. They also involve actions to support the water management goal of the Settlement, including constructing and operating new infrastructure to facilitate the recapture of Restoration releases to the San Joaquin River below the confluence of the Merced River.

Sacramento River Conservation Area Forum Program The nonprofit Sacramento River Conservation Area Forum works to protect, restore, and enhance the fisheries and riparian habitat along the Sacramento River in the primary and extended study areas, from Keswick Dam downriver to Verona. This is a cooperative effort to ensure that habitat restoration and management addresses not only the dynamics of riparian ecosystems, but also the realities of local agricultural and recreational issues associated with land use changes occurring along the river. The program (Resources Agency 2003) has goals to protect, restore, and enhance fisheries and riparian habitat along the Sacramento River and its tributaries. The Sacramento River Conservation Area Forum develops and implements site-specific and subreach plans for areas within the conservation area.

Iron Mountain Mine Restoration Plan The Iron Mountain Mine Restoration Plan identifies restoration actions to address injuries to or lost use of natural resources caused by acid mine drainage from the Iron Mountain Mine complex, located west of the upper Sacramento River in the primary study area. The plan involves restoring salmonid populations, riparian habitat, and instream ecological functions, as well as implementing restoration projects to compensate for the lost use of public areas and public services. The aquatic and riparian habitats affected by releases of hazardous substances at or from the Iron Mountain Mine site include the site's creeks (Boulder, Slickrock, Flat, and Spring) and the mainstem and tributaries of the Sacramento River from Keswick Reservoir to Red Bluff. As additional compensation for damage to natural resources, this project includes an option for the Federal government to acquire approximately 1,250 acres to be transferred into public ownership and administered by the U.S. Department of the Interior, Bureau of Land Management (BLM) (IMMTC 2002; NOAA 2009). The Iron Mountain Mine Trustee Council has allocated funds to several projects designed to meet the goals of the *Iron Mountain Mine Restoration Plan*.

Lower Deer Creek Falls Fish Passage Improvement Project The Lower Deer Creek Falls Fish Passage Improvement Project will improve access to 5.75 stream miles for fall-run, late fall-run, and spring-run Chinook salmon as well as steelhead. Work is under way by Deer Creek Irrigation District, DWR, and CDFW to develop an environmental flow enhancement program in lower Deer Creek. The goal of the program is to increase fish transportation flows downstream from Deer Creek Irrigation District. More than 25 miles of prime spawning habitat are available upstream from the Deer Creek Irrigation District diversion dam. Detailed topographic surveys of the area and preliminary engineering investigations have been suspended until additional funding becomes available.

Battle Creek Salmon and Steelhead Restoration Project The intent of the Battle Creek Salmon and Steelhead Restoration Project is to create habitat that can sustain additional populations of winter-run Chinook salmon to minimize the species' high risk of extinction. Upon its completion, the project will have reestablished approximately 42 miles of prime salmon and steelhead habitat on Battle Creek, plus an additional 6 miles on its tributaries; removed several hydroelectric dams; and developed and implemented a long-term adaptive management plan with dedicated funding sources to ensure the continued success of restoration efforts. The project is to be completed no later than 2019.

Butte Regional Conservation Plan The Butte Regional Conservation Plan (BRCP) is both a Federal habitat conservation plan and a State natural communities conservation plan. The BRCP, a voluntary plan coordinated by the Butte County Association of Governments, covers approximately the western half of Butte County, including all of the county's vernal pool landscapes. The BRCP will provide streamlined ESA permitting for transportation projects, land development, and other covered activities over the 30- to 50-year term of the permits. It will also provide comprehensive species, wetlands, and ecosystem conservation and contribute to the recovery of endangered species within the plan area.

The development of the BRCP is a complex multiyear effort that will replace the existing environmental permitting process. The release of the BRCP and EIS/R for public review is scheduled for fall 2014. The formal public draft BRCP and EIS/R were submitted to the USFWS regional office in April 2014 for review.

North-of-Delta Offstream Storage Investigation The North-of-Delta Offstream Storage Investigation is a feasibility study being performed by Reclamation and DWR, in partnership with local interests. Pursuant to the CALFED solution principles, storage locations that would not add a new dam on a major stream were considered and evaluated. As its name indicates, the North-of-Delta Offstream Storage Investigation focuses on offstream storage north of the Delta – specifically, potential projects for offstream storage of surface water at Sites Reservoir in the Sacramento River basin.

Offstream storage located north-of-the-Delta would require conveying water from the Sacramento River or one of its major tributaries to the new storage location. An offstream storage conveyance system could use either existing diversions and canals or new diversions and conveyance. Water would be diverted during periods of relatively higher flow through the conveyance system, into the new offstream storage reservoir, and stored until it is needed to meet the planning objectives.

Such storage could increase water supply reliability for all beneficial uses (agricultural, urban, and environmental). The Sites Reservoir Project could contribute to cumulative effects on water supplies and associated resources. The project could increase water supplies available for export in years when export supplies otherwise would be limited. This project also could modify the timing and magnitude of upstream reservoir releases in wet years.

A notice of intent/notice of preparation for this project was issued in November 2001 and public scoping for the environmental document occurred in January 2002. The complete plan formulation report was published in September 2008 and the Final EIS/R and Feasibility Report are anticipated for release in 2014.

Fremont Landing Conservation Bank The 100-acre Fremont Landing Conservation Bank in Yolo County functions as a mitigation bank providing credits for riparian floodplain forest or shaded riverine aquatic habitat. The mitigation bank serves portions of Tehama, Shasta, Glenn, Butte, Colusa, Sutter, Yuba, Yolo, Placer, Solano, Sacramento, Amador, Contra Costa, San Joaquin, Calaveras, Alameda, Stanislaus, Tuolumne, Merced, and Mariposa counties. Credits may be designated to provide habitat for special-status anadromous salmonids – Sacramento River winter-run, Central Valley spring-run, and Central Valley fall/late fall-run Chinook salmon as well as Central Valley steelhead. NMFS approved the site as part of an umbrella agreement that covers several Central Valley mitigation banking sites (Conservation Fund 2010). A mitigated negative declaration was issued in 2009 (BDCP 2012).

Yuba Salmon Forum Fish Passage Studies (Upper Yuba River Studies Program) The purpose of the Yuba Salmon Forum Fish Passage Studies is to take two sets of actions concurrently: (1) identify, evaluate, recommend, and seek to achieve implementation of effective near-term and long-term actions to achieve viable salmonid populations in the Yuba River watershed to contribute to recovery goals; and (2) consider other beneficial uses of water resources and habitat values in neighboring watersheds, as part of Central Valley salmonid recovery actions. The Yuba Salmon Forum adopted the *Draft Yuba River Salmon Forum Studies* on June 24, 2011. These six studies provide information to Yuba Salmon Forum members that they may find useful in making decisions about the introduction of anadromous salmonids (Chinook salmon (*Oncorhynchus tshawytscha*) and central Valley steelhead (*O. mykiss*)) into the Yuba River basin upstream from USACE's Englebright Dam. The Forum's Technical Work Group also completed the *Assessment of Infrastructure and Related Items to Support Anadromous Fish Passage to the Yuba River Watershed* in March 2013.

Davis-Woodland Water Supply Project The Davis-Woodland Water Supply Project will replace deteriorating groundwater supplies with safer, more reliable surface water supplies from the Sacramento River. The three primary objectives of the project are to provide a reliable water supply to meet existing and future needs, to improve water quality for drinking water supplies, and to improve the quality of treated wastewater effluent discharged by the project partners (the Cities of Woodland and Davis and the University of California, Davis) through 2040. Once complete, the project will serve more than two-thirds of the urban population of Yolo County.

Project plans include a jointly owned and operated intake on the Sacramento River, raw-water pipelines connecting the intake to a new regional water treatment plant, and separate pipelines delivering treated water to the project partners. Improvements to existing water supply systems will vary for Woodland and Davis and will include facilities such as distribution pipelines, water storage tanks, and booster pump stations.

The project will divert up to 45,000 acre-feet of water per year from the Sacramento River. Water rights were granted in March 2011 and will be subject to conditions imposed by the State. Water diversions will be limited during summer and other dry periods. A more senior water right for 10,000 acre-feet was purchased to provide summer water supply. Groundwater will continue to be used by Woodland and Davis when demand for water cannot be met by surface water supplies alone. The regional water supply project is currently under construction and operations are anticipated beginning in 2017.

North Bay Aqueduct Alternative Intake Project DWR proposes to implement the North Bay Aqueduct Alternative Intake Project to improve water quality and to provide reliable deliveries of SWP supplies to its contractors, the Solano County Water Agency and the Napa County Flood Control and Water Conservation District. This proposed project would include the construction and operation of an alternative intake on the Sacramento River, generally upstream from the Sacramento Regional Wastewater Treatment Plant, and connect it to the existing North Bay Aqueduct system by a new segment of pipe. The proposed alternative intake would be operated in conjunction with the existing North Bay Aqueduct intake at Barker Slough. The North Bay Aqueduct Alternative Intake Project would include the following facilities:

- A new alternative intake structure and pump station on the Sacramento River with state-of-the-art, positive-barrier fish screens
- A new pipeline segment to convey the water from the alternative intake to a point of connection with the existing North Bay Aqueduct near the North Bay Regional Water Treatment Plant
- Other project-related support facilities such as surge tanks

The notice of preparation for the North Bay Aqueduct Alternative Intake Project EIR was published in November 2009 (DWR 2009). A scoping report was released in February 2010 (ESA 2010). It is anticipated that the public review DEIR will be available in 2014.

Lower Clear Creek Anadromous Fish Restoration and Management Project The anadromous fish restoration and management actions of the Lower Clear Creek Anadromous Fish Restoration and Management Project will occur on public and private lands in the lower Clear Creek watershed, located west of Redding in Shasta County.

Beginning in the early 1990s, multiple Federal, State, and local agencies and private stakeholder groups concerned about lower Clear Creek began to plan and implement watershed restoration activities to reverse the effects of Whiskeytown Dam, Saeltzer Dam, placer and dredger gold mining, instream aggregate mining, road-related erosion, and decades of fire suppression. Since that time, the groups that formed the Clear Creek Restoration Team have implemented multiple resource inventories and restoration projects, including dam removal, gravel augmentation, flow augmentation, channel and floodplain restoration, erosion control, fuels reduction, and control of nonnative vegetation.

North Delta Flood Control and Ecosystem Restoration Project DWR certified the EIR for the North Delta Flood Control and Ecosystem Restoration Project in 2010 and filed a notice of determination with the Governor's Office of Planning and Research on November 9, 2010. This project will implement flood control improvements in the north Delta, principally on and around McCormack-Williamson Tract, Dead Horse Island, and Grizzly Slough, in a manner that benefits aquatic and terrestrial habitats, species, and ecological processes. Flood control improvements are needed to reduce damage to land uses, infrastructure, and the Bay-Delta ecosystem caused by catastrophic levee failures in the Delta.

Two-Gates Fish Protection Demonstration Project Reclamation is currently studying the proposed Two-Gates Demonstration Project, a 5-year experiment to validate a new behavioral model for delta smelt and study the effects of modifying Delta flows to protect delta smelt and other sensitive aquatic species from entrainment in CVP and SWP export pumps. Research suggests that the pre-spawning migration of adult delta smelt is tied to sediment and suspended particles in the water (turbidity). Temporary gates would be placed across Old River and Connection Slough in the central Delta. These gates would operate at two times of year: from December to March, to keep turbid water away from the CVP and SWP export pumps, thus keeping adult delta smelt away from the pumps; and in March and June, to prevent entrainment of larvae and juvenile delta smelt by the export pumps.

Franks Tract Project Reclamation and DWR propose to implement the Franks Tract Project to improve water quality and fisheries conditions in the Delta. Reclamation and DWR are evaluating installing operable gates to control the flow of water at key locations (Threemile Slough and/or West False River) to limit the entry of fish species of concern and higher salinity water into Franks Tract and other areas of the Delta with high fish mortalities. In addition to improving water quality, the gates would limit migration of delta smelt into the central and south Delta, where their survival rates are reduced. By protecting fish resources, this project also would improve the operational reliability of the CVP and SWP because curtailments (pumping restrictions) in project operations would likely be less frequent.

A plan of study for the Franks Tract Project was completed in August 2007. The notice of intent was published September 22, 2008, the Initial Alternatives Information Report was completed in February 2010, and the Plan Formulation Report was completed in 2013. The project is still under consideration by Reclamation and DWR.

Dutch Slough Tidal Marsh Restoration Project This proposed project is a cooperative partnership between DWR, CALFED, the California Coastal Conservancy, landowners, the Natural Heritage Institute, the City of Oakley, Ironhouse Sanitary District, and private consultants. The project entails restoring wetlands and uplands and providing public access to the 1,166-acre Dutch Slough property owned by DWR. The property comprises three parcels, separated by narrow human-made sloughs, that were historically used for agricultural uses and grazing.

The primary goal of the Dutch Slough Tidal Marsh Restoration Project is to provide ecosystem benefits, including habitats for sensitive aquatic species. The project will be designed to maximize opportunities to assess the development of those habitats and measure ecosystem responses so that future Delta restoration projects will be more successful. This proposed project also provides an important opportunity to improve planners' understanding of restoration science in tidal marsh wetland ecosystems in the region (DWR 2010). Construction is scheduled to begin in summer 2014 with levee breaching anticipated in 2015.

Suisun Marsh Management, Preservation, and Restoration Plan Federal and State agencies jointly developed this comprehensive 30-year regional plan to address the use of resources on about 52,000 acres of wetland and upland habitats in Suisun Marsh near Fairfield. The focus of the *Suisun Marsh Management, Preservation, and Restoration Plan* is to achieve an acceptable multiple-stakeholder approach to the restoration of tidal wetlands and the enhancement of managed wetlands and their functions. The plan balances implementation of the CALFED Program, the Suisun Marsh Preservation Agreement, and other management and restoration programs for Suisun Marsh and is based on voluntary participation by private landowners.

DWR and Reclamation have collaboratively prepared the environmental documents with NMFS, CDFW, and the Suisun Resource Conservation District. The notice of intent/notice of preparation was published in November 2003. The Final EIS/R was made available in December 2011 (DOI et al. 2011) and the ROD was signed in April 2014.

In-Delta Storage Program (Delta Wetlands Project) DWR, in coordination with the California Bay-Delta Authority and with technical assistance from Reclamation, completed the State feasibility study for the In-Delta Storage Program in the south Delta, within the extended study area. The In-Delta Storage Project would provide capacity to store approximately 217 thousand acre-feet of water in the south Delta for a wide array of water supply, water quality, and ecosystem benefits. The project would consist of two storage islands (Webb Tract and Bacon Island) and two habitat islands (Holland Tract and Bouldin Island), an embankment design, consolidated inlet and outlet structures, project operations, and habitat management plans. The objectives of the project are to enhance water supply reliability and the operational flexibility of the CVP/SWP system, contribute to ecosystem restoration, and provide water for the Environmental Water Account (DWR 2011b). Detailed planning work by the State on the In-Delta Storage Project has been suspended since July 2006 when State funding was cut (DWR 2011b); however, a Final EIR was certified in 2012 by Semitropic Water Storage District and other environmental documentation is under way.

Los Vaqueros Reservoir Expansion Project Los Vaqueros Reservoir was completed in 1997 to provide 100,000 acre-feet of offstream water storage to improve water quality and provide emergency storage for Contra Costa Water

District (CCWD) customers. The purpose of this project is to enhance the Delta environment and improve the San Francisco Bay Area's (Bay Area) water supply reliability and water quality by developing water supplies for environmental water management and helping to meet municipal and industrial water demands during drought and emergency periods by expanding the existing reservoir.

To date, the project has consisted of an expansion of Los Vaqueros Reservoir from 100,000 acre-feet to 160,000 acre-feet, which required a dam raise, the relocation of recreation facilities, and an upgrade of the pumps at the Transfer Pump Station. The dam raise to 160,000 acre-feet was completed in 2012 and mitigation activities are scheduled for completion in 2013. Los Vaqueros Reservoir could be further expanded up to a total of 500,000 acre-feet. New Delta intakes, pumps, and pipelines would be required to fill the additional reservoir capacity, and water deliveries would be made from the expanded reservoir to Bay Area beneficiaries through new conveyance facilities.

Completion of the Draft Federal Feasibility Report is planned for 2014 and a final report is to be completed in 2015. A final decision on further expansion of the reservoir beyond 160,000 acre-feet is expected to occur in 2016, depending on the level of participation by other Bay Area water agencies, Reclamation, and DWR. Project implementation will also consider the CCWD Board Principles and the additional assurances, commitments, and requirements adopted by the CCWD Board on June 25, 2003.

East Bay Municipal Utility District Water Supply Management Program 2040 The Water Supply Management Program 2040 (WSMP 2040) is a program-level effort that estimates EBMUD's water supply needs over a 30-year planning horizon and proposes a diverse portfolio of policy initiatives and potential projects to ensure that those needs can be met in dry years. On October 13, 2009, the EBMUD Board of Directors approved the WSMP 2040. The CEQA analysis was challenged in court, and in a ruling issued on April 11, 2011, EBMUD was directed to analyze certain plan components in more detail. On May 24, 2011, the EBMUD Board set aside certification of the WSMP 2040 Program EIR and directed staff members to revise the program. That revision effort has since been completed, and on April 24, 2012, the EBMUD Board of Directors certified the revised program EIR and adopted the revised final plan for the WSMP 2040 (EBMUD 2012).

Bay Area Regional Desalination Project The Bay Area's largest water agencies (CCWD, EBMUD, the San Francisco Public Utilities Commission, the Santa Clara Valley Water District, and the Alameda County Flood Control and Water Conservation District – Zone 7) are working together to develop a regional desalination project to serve the needs of more than 5.6 million residents and businesses in the region. The project under consideration would use water from the Delta withdrawn at CCWD's Mallard Slough Pump Station, located in eastern Contra Costa County, to produce 20 million gallons per day of desalinated water for delivery to residential and business customers in the region. Water produced by this project could be blended with supplies from CCWD, EBMUD (Mokelumne Aqueduct), or both. Other parties would receive project water through transfers or wheeling. The water from the Bay Area Regional Desalination Project could be fully treated (two-pass reverse osmosis) or require further treatment (one-pass reverse osmosis), depending on the delivery point into either the CCWD or EBMUD system. The project would operate continuously in all water year types, with the possibility of storing water (including by exchange or transfer) in CCWD's Los Vaqueros Reservoir when demand is less than plant capacity.

Upper San Joaquin River Basin Storage Investigation (Temperance Flat Reservoir) The Upper San Joaquin River Basin Storage Investigation is a feasibility study being performed by Reclamation and DWR. The purpose of the Upper San Joaquin River Basin Storage Investigation is to determine the type and extent of Federal, State, and regional interests in a potential project in the upper San Joaquin River watershed with the following goals: expand water storage capacity; improve water supply reliability and flexibility for agricultural, urban, and environmental uses; and enhance San Joaquin River water temperature and flow conditions to support efforts for anadromous fish restoration. This investigation is one of five surface water storage studies recommended in the August 2000 Programmatic ROD for the CALFED Final PEIS/R. A plan formulation report for the project was released in October 2008 (Reclamation and DWR 2008). A public draft feasibility report was released in early 2014.

San Luis Drainage Reevaluation Program The San Luis Unit (drainage study area) was authorized by Congress in Public Law 86-488 (74 Statutes 156), June 3, 1960, and amended by Section 101(e) of the Act of October 18, 1986, Public Law 99-500. The project purpose is to provide agricultural drainage service to the San Luis Unit to achieve a long-term, sustainable salt and water balance in the root zone of irrigated lands in the San Luis Unit and adjacent areas. Of the 730,000 acres in the drainage study area, about 379,000 acres are drainage-impaired and constitute the drainage service area. Reclamation estimates that installing subsurface drainage systems in two-thirds of this area by the end of the 50-year planning horizon would maintain the arability of the root zone throughout the entire 379,000 acres. The alternatives are the In-Valley/Drainage-Impaired Area Land Retirement Alternative and the In-Valley/Water Needs Land Retirement Alternative. Common features proposed for both alternatives are a drainage collection system, regional drainage reuse facility, conveyance system, selenium biotreatment, evaporation ponds, mitigation facilities, and land retirement.

Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) The CV-SALTS initiative is a collaborative effort among 26 stakeholder groups to realize reductions in salt accumulation in the Central Valley. These groups represent a broad coalition of agriculture, municipalities, industry, and regulatory agencies. Represented by the Central Valley Salinity Coalition, they are working with the Central Valley Regional Water Quality Control Board (CVRWQCB) to address the valley's salinity problems. The goal of the CV-SALTS initiative is to adopt long-term solutions to salt management that will enhance water quality and economic sustainability in the valley. The CV-SALTS initiative has completed pilot studies on the sources and effects of salts in 13 percent of the affected areas; working in partnership with Reclamation, it will complete salts studies for the east and west sides of the San Joaquin River.

San Joaquin River at Vernalis Salt and Boron TMDL and Basin Plan Amendment The CV-SALTS stakeholder initiative was created to develop new approaches to protect soils and water from salt that has been slowly and steadily accumulating in the San Joaquin River watershed. The CV-SALTS stakeholder initiative will initiate a research effort that will review and determine the appropriate salinity concentration for the San Joaquin River to maintain all of the beneficial uses of the river. Reclamation is currently collaborating with CV-SALTS and the Regional Water Board to implement a real-time salinity management system that will satisfy the TMDL requirement for San Joaquin River salinity concentration.

B. F. Sisk Dam Corrective Action Project B.F. Sisk Dam (also known as San Luis Dam) is a 300-foot-high, compacted earthfill embankment located on the west side of the Central Valley approximately 12 miles west of Los Banos. Owned by Reclamation and operated by DWR, the dam is more than 3.5 miles long. B.F. Sisk Dam impounds San Luis Reservoir, which has a total capacity of more than 2 million acre-feet. The dam was built between 1963 and 1967 to provide supplemental storage of irrigation water for the CVP and municipal and industrial water for the SWP. The Gianelli Pumping-Generating Plant lifts water from both the California Aqueduct and the Delta-Mendota Canal (via O'Neill Forebay) into San Luis Reservoir for storage.

The dam and reservoir are located in an area of high potential for severe earthquakes on active faults, primarily the Ortigalita Fault, which crosses the reservoir. A series of studies and analyses that culminated in a seismic-risk analysis completed in 2006 found justification to act to reduce the risk to the downstream public of seismic damage to the dam. The current phase of the Safety of Dams project is referred to as a corrective action study and is ongoing. The study will include feasibility-level designs, environmental documentation, selection of a preferred alternative, and a modification report to the Federal Office of Management and Budget and the U.S. Congress.

San Luis Reservoir Low Point Improvement Project Reclamation is investigating 3 alternatives to address water quality problems within the CVP's San Felipe Division (Santa Clara and San Benito counties) that arise when San Luis Reservoir levels drop below 300 thousand acre-feet during late summer in dry water years, resulting in large algal blooms. Santa Clara Valley Water

District has proposed the San Luis Reservoir Low Point Improvement Project to maintain a high-quality, reliable, and cost-effective water supply for the water district and other contractors of the San Felipe Division. Santa Clara Valley Water District wants to ensure that it and other San Felipe Division contractors receive their annual CVP contract allocations at the time and the level of quality needed to meet water supply commitments. The project objectives are as follows:

- Avoid supply interruptions when water is needed by increasing the certainty of meeting the requested delivery schedule throughout the year to south-of-Delta contractors dependent on San Luis Reservoir.
- Increase the reliability and quantity of yearly allocations to south-of-Delta contractors dependent on San Luis Reservoir.
- Minimize the downward population trends of native species that are not listed.
- Announce higher allocations earlier in the season to south-of-Delta contractors dependent on San Luis Reservoir without sacrificing accuracy of the allocation forecasts.

Shasta-Trinity National Forest Land and Resource Management Plan The Shasta-Trinity National Forest Land and Resource Management Plan (LRMP) was most recently revised in 1995 (USFS 1995). This document is revised every 10–15 years; it supersedes any previous forest plans, timber management plans, or National Recreation Area (NRA) plans. This is a forest-wide land use plan developed to guide resource management within the forest. It contains the goals and objectives for Shasta-Trinity National Forest, its standards and guidelines, management prescriptions to be applied to land areas, and management area direction. It also sets forth requirements for monitoring and implementation of the plan. The allocations associated with this plan not only reflect the capability and suitability of the land for various uses, but also respond to the public issues (such as recommendations for wild and scenic river designations) and development opportunities identified during the planning process.

Mendocino National Forest Land and Resources Management Plan The management direction, objectives, and standards and guidelines of the Mendocino National Forest LRMP are applicable to an isolated 488-acre parcel of land managed by the Mendocino National Forest along the east bank of the Sacramento River in the general vicinity of the decommissioned Red Bluff Diversion Dam. In addition to a developed recreation area (Sycamore Campground), this parcel provides river access, habitat for special-status species and undeveloped open space used by the public for hiking, biking, and other recreational activities.

Qualitative Assessment of Actions Related to Flood Management The actions related to flood management described below were identified as present or reasonably foreseeable.

Central Valley Flood Protection Plan Legislation passed in 2007 directs DWR to develop three documents that will guide improvement of integrated flood management:

- *State Plan of Flood Control Descriptive Document* to inventory and describe the flood management facilities, land, programs, conditions, and mode of operations and maintenance for the State/Federal flood protection system in the Central Valley.
- *Flood Control System Status Report* to assess the status of the facilities included in the State Plan of Flood Control Descriptive Document, identify deficiencies, and make recommendations.
- *Central Valley Flood Protection Plan* (CVFPP) to describe a sustainable, integrated flood management plan that reflects a systemwide approach for protecting areas of the Central Valley that currently receive protection from flooding by existing facilities of the State Plan of Flood Control. It is supported by the *State Plan of Flood Control Descriptive Document*, the *Flood Control System Status Report*, and the *CVFPP Final Program Environmental Impact Report*.

The CVFPP is a sustainable, integrated flood management plan that describes the existing flood risk in the Central Valley and recommends actions to reduce the probability and consequences of flooding. Produced in partnership with Federal, tribal, local, and regional partners and other interested parties, the CVFPP also identifies the mutual goals, objectives, and constraints important in the planning process; distinguishes plan elements that address mutual flood risks; and recommends improvements to the State/Federal flood protection system. The 2012 CVFPP was completed by DWR and adopted by the Central Valley Flood Protection Board in July 2012 (DWR 2012). It is currently being implemented through two basin-wide feasibility studies for the Sacramento and San Joaquin river basins, respectively.

CALFED Levee System Integrity Program DWR, CDFW, and USACE implement the CALFED Levee System Integrity Program, which maintains and improves the integrity of the Bay-Delta estuary's levee system. The goal of the Levee System Integrity Program is to reduce risks to land use and associated economic activities, water supply, agricultural and residential uses, infrastructure, and the ecosystem from the effects of catastrophic breaching of Delta levees. Resources protected by the program include water quality, ecosystem health, infrastructure such as utilities and transportation corridors, agriculture, and recreational industries.

Protection and maintenance of nearly 700 miles of Delta levees has increased since 2000. Maintenance has been ongoing along more than 600 miles of eligible project and nonproject levees, and levee stability has been improved for more than 45 additional miles of levees. Large levee rehabilitation projects have been undertaken on numerous islands. Projects have also been implemented to grow native vegetation, reuse more than 2 million cubic yards of dredged material for levee stability and habitat development, and develop approximately 50 acres of riparian and wetland habitat and 3,000 linear feet of shaded riverine aquatic habitat (CALFED 2011).

Sacramento River Bank Protection Project The Sacramento River Bank Protection Project is a continuing construction project authorized by Section 203 of the Flood Control Act of 1960. USACE is responsible for implementation of this project in conjunction with its non-Federal partner, the Central Valley Flood Protection Board. The project's purpose is to provide protection to the existing levee and flood control facilities of the Sacramento River Flood Control Project. The project is to be completed in three phases. To date, a total of about 820,000 feet of riverbank has been stabilized under the project. During Phase III, USACE and the Central Valley Flood Protection Board will consider multiple objectives – not only controlling bank erosion, but also addressing other threats to the flood risk management system such as through-seepage, underseepage, and levee height deficiencies, while providing ecosystem restoration. Implementing Phase III will be critical to ensure that project levees seriously threatened by erosion will continue to receive corrective measures to prevent levee failure, catastrophic damage, and possible loss of life. Planning and development of Phase III began recently and will include a comprehensive sediment study, a thorough economic analysis, continued biological studies, a comprehensive cultural resources survey, a detailed real estate plan, and an updated mitigation site inventory.

Folsom Dam Joint Federal Project Folsom Dam regulates flows in the American River for flood control, and releases from Folsom Reservoir are used for irrigation, power, municipal and industrial, fish and wildlife, water quality, and other purposes. The "Folsom Facility" comprises Folsom Dam and Reservoir, left and right earthfill wing dams, Mormon Island Auxiliary Dam, and eight earthfill dikes that protect the surrounding communities, Folsom and Granite Bay.

The Folsom Joint Federal Project is a collaborative effort by Reclamation and USACE to address the hydrologic risk related to dam safety at the Folsom Facility, and to improve flood protection. This project includes construction of a new auxiliary spillway southwest of the existing main concrete dam. When completed in 2017, the auxiliary spillway will include a 1,000-foot-long approach channel beginning in Folsom Reservoir, a concrete control structure with 6 gates, a 2,100-foot-long auxiliary spillway chute, and a stilling basin that will act as an energy dissipation structure as water discharges enter the American River below the main concrete Folsom Dam. The new facility will allow Reclamation's dam operators to better manage large floods by safely releasing more water from Folsom Reservoir earlier during a large storm through both the spillway gates on Folsom Dam and the new control structure's six gates, thus reducing hydrologic risk and leaving more storage capacity in the reservoir. The Folsom Joint Federal Project also includes improvements to appurtenant structures, including several dikes and Mormon Island Auxiliary Dam. Construction on the appurtenant structures began in December 2007 and is expected to be completed in late 2017.

Natomas Levee Improvement Program Landside Improvement Project The Sacramento Area Flood Control Agency, acting in conjunction with USACE, is implementing the multiple-phase Natomas Levee Improvement Program Landside Improvements Project along the lower Sacramento River in the extended study area. The project involves improving the perimeter levee system of the Natomas basin in Sutter and Sacramento counties and modifying associated landscaping and irrigation/drainage infrastructure. The project objectives are to provide at least a 100-year level of flood protection to the Natomas basin as quickly as possible, provide "200-year" protection to the basin over time, and avoid any substantial increase in expected annual damages as new development occurs in the basin (SAFCA 2007, 2010).

Multiple CEQA and NEPA documents have been issued by the Sacramento Area Flood Control Agency and USACE for various phases of this project since 2008. The Final EIS for Phase 4a of the project was issued by USACE in February 2010. Some phases of the project have been completed. Further construction and completion of the project is contingent on Federal funding.

West Sacramento Levee Improvement Program The West Sacramento Levee Improvement Program involves constructing improvements to the levees that protect West Sacramento to meet local and Federal flood protection criteria. The program area includes the entire boundaries of the West Sacramento Area Flood Control Agency, which encompass portions of the Sacramento River, the Yolo and Sacramento bypasses, and the Sacramento Deep Water Ship Channel. The levee system associated with these waterways includes more than 50 miles of levees in Reclamation Districts 900, 537, and 811; DWR's Maintenance Area 4; and the Sacramento Deep Water Ship Channel. These levees completely surround West Sacramento. The Final EIS/R for the West Sacramento Levee Improvements Program has been completed (City of West Sacramento 2012). Construction began in 2008 and is ongoing.

Delta Islands and Levees Feasibility Study The Delta Islands and Levees Feasibility Study is USACE's mechanism to participate in a cost-shared solution to address ecosystem restoration needs, flood risk management problems, and related water resources in the Delta and Suisun Marsh area. A Feasibility Cost Share Agreement was executed on May 26, 2006 with DWR, the non-Federal sponsor. The USACE-DWR study team meets regularly to move the study forward and holds periodic agency coordination meetings with associated Federal, State, and local agencies. The study will culminate in a feasibility report that will make recommendations on construction projects and/or additional studies for authorization by Congress (USACE 2012). The project is on USACE's priority list and the scope is currently being revised.

Qualitative Assessment of Actions Related to Energy The actions related to energy that are described below were identified as present or reasonably foreseeable.

Increased Hydropower Generation Capacity at Lewiston Dam In March 2011, the U.S. Department of the Interior released the results of an internal study that shows it could generate up to 1,000 gigawatt-hours of electricity annually by adding hydropower capacity at 70 of its existing dams, canals, tunnels, and other water-handling facilities. The report, *Hydropower Resource Assessment at Existing Reclamation Facilities*, studied 530 sites throughout Reclamation's jurisdiction and preliminarily identified the 70 facilities with the most potential to add hydropower. The Trinity Public Utilities District and Reclamation intend to boost the power-generating capacity at the Lewiston Dam from the existing 350 kilowatts. This upgrade would allow for better control of the flow from the dam to the river, and would provide an increase in revenue from power generation (Reclamation 2011).

Federal Energy Regulatory Commission Project Licensing The Federal Energy Regulatory Commission (FERC) regulates non-Federal hydropower projects. FERC is responsible for the issuance of licenses for new hydropower projects, the continuance of existing projects (relicensing), and oversight of all ongoing project operations. Ongoing operations include dam safety inspections and environmental monitoring. Additionally, FERC may issue a preliminary permit for up to 3 years, which does not authorize construction but maintains the priority of application for license while the permittee studies the site and prepares to apply for a license. The permittee must submit periodic reports on the status of its studies. It is not necessary to obtain a permit to apply for or receive a license.

Shasta Dam is a Federal project and thus is not subject to FERC oversight; however, numerous hydropower projects in the primary and extended study areas are subject to this oversight and permitting process.

Pacific Gas & Electric Company Pit River 3, 4 & 5 Hydroelectric Projects License Implementation The Pit River 3, 4 & 5 Hydroelectric Projects' license implementation involves three developments with a total of four dams, four reservoirs, and three powerhouses. Pit River 3, 4 & 5 is a 312.33-megawatt project located on the Pit River (the Sacramento River's largest tributary) that occupies 4,330 acres of both publicly owned and privately owned land.

Pacific Gas & Electric Company McCloud and Pit Rivers 6 and 7 FERC Relicensing The McCloud and Pit Rivers 6 and 7 FERC Relicensing includes the McCloud and Iron Canyon storage reservoirs, the Pit River 6 and 7 regulating reservoirs, the Pit 7 afterbay, two tunnels, three powerhouses, and transmission facilities. In 2010, the FERC Final EIS recommended the relicensing of the McCloud-Pit hydroelectric project, a total of 382 megawatt-hours, on the McCloud and Pit rivers in Shasta County. The McCloud and Pit 6, 7 is currently being operated under a preliminary permit.

California Department of Water Resources Oroville Facilities FERC Relicensing The 762-megawatt project is located on the Feather River in Butte County and occupies 6,240 acres of Federal lands. The Final EIR and notice of determination were issued in July 2008. The Final EIS was issued in May 2007 (DWR 2007). DWR is currently undergoing the relicensing process with FERC and operating under annual licenses.

Sacramento Municipal Utility District Upper American River Project FERC Relicensing The Sacramento Municipal Utility District's Upper American River Project is a hydroelectric facility located on the western slope of the Sierra Nevada. The facility is composed of several reservoirs and powerhouses located along streams and rivers within the American River basin. The FERC relicensing included the Iowa Hill Pumped Storage Development, a 400-megawatt pumped storage generating facility using the Slab Creek Reservoir as the lower reservoir and a new reservoir to be located on the top of Iowa Hill. The size of the Iowa Hill reservoir is under consideration and will range from 2,100 to 6,400 acre-feet.

Qualitative Assessment of Actions Related to Land Use Planning and Infrastructure Land use plans and policies are described in Chapter 17, "Land Use and Planning." Inconsistency with land use plans and policies does not necessarily indicate that adverse effects on the environment would occur. However, land use plans and policies guide development and land management activities that would affect the physical environment, and SLWRI actions could have additive or combined effects.

Antlers Bridge Replacement The California Department of Transportation (Caltrans), in cooperation with the Federal Highway Administration, is replacing Antlers Bridge over Shasta Lake, which is located on Interstate 5 near the community of Lakehead in Shasta County, in the primary study area. This project involves constructing a 1,942-foot, 5-lane segmental bridge with deep-pile foundations measuring 12 feet in diameter. The project also involves realigning a 0.4-mile-long segment of Interstate 5, which requires hillside excavation, construction of a 5-lane freeway section, and demolition of the existing 1,500 feet of steel deck truss bridge. The new bridge is being constructed next to the existing bridge, which will remain open to traffic until the new bridge is completed. This project will affect visual resources, fish and wildlife, and water quality standards. However, incorporation of mitigation will reduce these impacts to a less-than-significant level. The project is not expected to have any other significant impacts (Caltrans and FHWA 2007). Construction began in 2009 and is expected to be completed in 2015.

Jellys Ferry Bridge Replacement The Tehama County Department of Public Works in cooperation with Caltrans is proposing to replace the existing the Jellys Ferry Bridge over the Sacramento River, north of Red Bluff, in northern Tehama County, California. After conducting a seismic assessment, as part of the Local Bridge Seismic Safety Retrofit Program (LSSRP), the bridge was classified structurally and seismically deficient (Quincy 1997). Based on the results of the assessment, the Tehama County Department of Public Works determined (with Caltrans concurrence) to replace rather than retrofit the existing bridge. The bridge will span the Sacramento River with abutments on adjacent sides of the river.

Moody Flats Quarry Shasta County is the Lead Agency under the California Environmental Quality Act (CEQA) and is in the process of preparing a DEIR for the project identified as Moody Flats Quarry. The project site is located about one mile south of Shasta Lake, about one mile west of Interstate 5, and adjacent to the north side of the City of Shasta Lake. The Union Pacific Railroad runs in a general northeast-southwest direction through the site. Access to the project would be via a proposed access road connecting to the east side of Wonderland Boulevard at a point approximately 0.4 miles south of the intersection of Wonderland Boulevard and Old Oregon Trail. The site is currently undeveloped (Shasta County 2011).

This project would develop a 345-acre hardrock quarry (including a 60-acre overburden fill area), a 75-acre processing area, and a 10-acre railroad cut area. This project would include an aggregate processing facility, ancillary aggregate product facilities (e.g., concrete plant, asphalt batch plant, and recycled construction materials plant) and aggregate truck and railcar load-out facility within the approximately 1,900-acre property. A total of about 430 acres would be disturbed, and about 370 acres would be reclaimed. Production and distribution goals include approximately 1.5 million tons of aggregate shipped by rail to regional markets annually, and 0.5 million tons of aggregate and finished products to be distributed to local markets by trucks. Maximum proposed annual aggregate sales for the project would be 2 million tons per year. The proposed term of the use permit would be 100 years (Shasta County 2011).

Mountain Gate at Shasta Mixed-Use Area Plan The City of Shasta Lake is the Lead Agency under CEQA has prepared a DEIR for the project identified as the Mountain Gate at Shasta Mixed-Use Area Plan. The proposed project would develop the 590-acre property with approximately 1,604 housing units, up to 195,584 square feet of nonresidential development, and 236 acres of open space, parks and trails. The project site is located in the northeast portion of the City of Shasta Lake, approximately 8 miles north of the City of Redding and approximately three miles from the south shore of Shasta Lake. The site is undeveloped with the exception of foot trails and vehicle tracks. The project vicinity has emergent wetlands and riverine habitats, including Moody Creek and Rancheria Creek and several unnamed ephemeral tributaries (City of Shasta Lake 2014).

3.3 Resources Eliminated from Further Consideration

CEQA and the State CEQA Guidelines provide for identification and elimination from detailed study of the issues that are not significant or that have been covered by prior environmental review (PRC Section 21002.1; State CEQA Guidelines, Section 15143). The NEPA regulations provide similar provisions (Title 40, CFR Section 1501.7(a)(3)).

During initial scoping with the public and governmental agencies, and based on information obtained through literature review, agency correspondence, consultations, and field data collection, it was determined that no resource areas could be eliminated from detailed study. Therefore, all resource areas covered by NEPA and CEQA are addressed in this EIS.

3.4 Regulatory Framework

The following section generally describes the Federal, State, and local regulatory framework for the SLWRI. For a more detailed discussion of the "Regulatory Framework" by resource area, see Chapters 4 through 25. In addition, Chapter 26, "Other Required Disclosures," further describes the Federal and State laws, rules and regulations, Executive Orders, and compliance requirements that may be required if an alternative is selected for implementation.

3.4.1 Federal

National Environmental Policy Act

NEPA is the nation's broadest environmental law, applying to all Federal agencies and most of the activities they manage, regulate, or fund that affect the environment. This law requires Federal agencies to disclose and consider the environmental implications of their proposed actions. NEPA establishes environmental policies for the nation, provides an interdisciplinary framework for Federal agencies to avoid or minimize environmental impacts, and contains action-forcing procedures to ensure that Federal agency decision makers take environmental factors into account.

Federal Clean Water Act

Section 404 Section 404 of the CWA requires that a permit be obtained from USACE for the discharge of dredged or fill material into "waters of the United States, including wetlands." Waters of the United States are wetlands and lakes, rivers, streams, and their tributaries. Waters of the United States are defined for regulatory purposes, at Title 33, CFR Section 328.3, as follows:

> *(1) All waters which are currently used, or were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of tide; (2) All interstate waters, including interstate wetlands; (3) All other waters such as intrastate lakes, rivers, streams, mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation or destruction of which could affect interstate or foreign commerce; (4) All impoundments of waters otherwise defined as waters of the United States under the definition; (5) Tributaries of waters identified in paragraphs 1–4 in this section; (6) The territorial seas; and (7) Wetlands adjacent to waters identified in paragraphs 1–6 in this section.*

CWA Section 404(b) requires that USACE process permits in compliance with guidelines developed by the U.S. Environmental Protection Agency (EPA). These guidelines (the CWA Section 404(b)(1) Guidelines) require the analysis of available alternatives that meet the project’s purpose and need, including those alternatives that avoid and minimize discharges of dredged or fill materials in waters. Once alternatives deemed to be practicable have been identified, the only action that USACE can permit must be the least environmentally damaging practicable alternative.

Actions typically subject to Section 404 requirements are those that would take place in wetlands or stream channels, including intermittent streams, even if they have been realigned. For actions occurring within stream channels, a permit under Section 404 would be needed for any discharge activity below the ordinary high-water mark. (The ordinary high-water mark is the line on the shore established by the fluctuations of water. It is indicated by physical characteristics such as a clear, natural line impressed on the bank; shelving; changes in the character of soil; destruction of terrestrial vegetation; or the presence of litter or debris.)

The Programmatic ROD for the CALFED Final PEIS/R includes a CWA Section 404 memorandum of understanding signed by Reclamation, EPA, USACE, and DWR. Under the terms of the memorandum of understanding, when a project proponent applies for a Section 404 individual permit for CALFED projects, the proponent is not required to reexamine program alternatives already analyzed in the CALFED PEIS/R. USACE and EPA will focus on project-level alternatives that are consistent with the CALFED PEIS/R when they select the least environmentally damaging practicable alternative at the time of a Section 404 permit decision.

Section 401 Under CWA Section 401, applicants for a Federal license or permit to conduct activities that may discharge a pollutant into waters of the United States must obtain certification from the state in which the discharge would originate. If appropriate, the certification must be obtained from the interstate water pollution control agency with jurisdiction over affected waters at the point where the discharge would originate. Therefore, all projects that have a Federal component and may affect state water quality (including projects that require approval from a Federal agency, such as issuance of a Section 404 permit) must also comply with CWA Section 401.

In California, the authority to grant water quality certification has been delegated to the State Water Board. Applications for water quality certification under CWA Section 401 are typically processed by the regional water quality control board with local jurisdiction – in this case, the CVRWQCB. For a project to receive water quality certification, the project's potential impacts must be evaluated in light of water quality standards and CWA Section 404 criteria that govern discharges of dredged and fill materials into waters of the United States.

Endangered Species Act

USFWS and NMFS share responsibility for implementing the ESA. Generally, USFWS manages terrestrial and freshwater species, while NMFS manages marine and anadromous species such as Chinook salmon. Both agencies ensure that ESA requirements are followed and evaluate projects that may affect the continued existence of a Federally listed (threatened or endangered) species.

Section 9 of the ESA prohibits the take of Federally listed species. "Take" is defined under the ESA, in part, as killing, harming, or harassing. Under Federal regulations, take is further defined to include habitat modification or degradation where it actually results in death or injury to wildlife by significantly impairing essential behavioral patterns – breeding, feeding, or sheltering.

Section 7 of the ESA outlines procedures for Federal interagency cooperation to conserve Federally listed species and designated critical habitat. Section 7(a)(2) requires Federal agencies to consult with USFWS to ensure that they are not undertaking, funding, permitting, or authorizing actions likely to jeopardize the continued existence of listed species. NMFS also ensures that projects will not adversely affect essential fish habitat, as defined in the 1996 Sustainable Fisheries Act (Public Law 104-297). The goal is to stop or reverse the continued loss of fish habitats by protecting, conserving, and enhancing habitat.

Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Conservation and Management Act (commonly known as Magnuson-Stevens Act) establishes a management system for national marine and estuarine fishery resources. This legislation requires Federal agencies to consult with NMFS regarding actions or proposed actions permitted, funded, or undertaken that may adversely affect "essential fish habitat." Essential fish habitat is defined as "waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity."

The Magnuson-Stevens Act states that migratory routes to and from the spawning grounds of anadromous fish are considered essential fish habitat. The phrase "adversely affect" refers to the creation of any impact that reduces the quality or quantity of essential fish habitat.

The concept of essential fish habitat is similar to that of "critical habitat" under the ESA; however, measures recommended by NMFS to protect essential fish habitat are advisory, not prescriptive. Federal activities that occur outside of essential fish habitat but that may nonetheless affect waters and substrate that constitute essential fish habitat must also be considered in the consultation process.

Under the Magnuson-Stevens Act, effects on habitat managed under the *Pacific Salmon Fishery Management Plan* must also be considered. The Magnuson-Stevens Act states that where appropriate, consultation regarding essential fish habitat should be consolidated with the interagency consultation, coordination, and environmental review procedures required by other Federal statutes, such as NEPA, the Fish and Wildlife Coordination Act, the CWA, and the ESA.

Fish and Wildlife Coordination Act

Coordination under the Fish and Wildlife Coordination Act is intended to promote conservation of fish and wildlife resources by preventing their loss or damage. It also provides for development and improvement of fish and wildlife resources in connection with water projects. Federal agencies that undertake water projects must fully consider recommendations made by USFWS, NMFS, and the appropriate fish and wildlife agency – in this case, CDFW – in their project reports and include measures to reduce impacts on fish and wildlife in project plans.

Rivers and Harbors Appropriation Act of 1899

The Rivers and Harbors Appropriation Act of 1899 (commonly known as the Rivers and Harbors Act) addresses activities that involve constructing dams, bridges, dikes, or other obstructions across any navigable water. To place any obstruction to navigation outside established Federal lines, or to excavate from or deposit material in such waters, a permit must be obtained from USACE. Navigable waters are defined in Title 33, CFR Section 329.4 as follows:

> *Those waters that are subject to the ebb and flow of the tide and/or are presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce. A determination of navigability, once made, applies laterally over the entire surface of the waterbody, and is not*

extinguished by later actions or events which impede or destroy navigable capacity.

Sections of the River and Harbors Act applicable to the SLWRI are described below.

Section 9 Section 9 (Title 33, U.S. Code (USC) Section 401) prohibits the construction of any dam or dike across any navigable water of the United States without consent from Congress and approval of the plans by the Chief of Engineers and the Secretary of the Army. Where the navigable portions of the water body lie wholly within the limits of a single state, the structure may be built under authority of that state's legislature if the location and plans, or any modification thereof, are approved by the Chief of Engineers and by the Secretary of the Army.

Section 10 Section 10 (Title 33, USC Section 403) prohibits the unauthorized obstruction or alteration of any navigable water of the United States. Construction of any structure in or over any navigable water of the United States, or the accomplishment of other work affecting the course, location, condition, or physical capacity of such waters, is unlawful unless the work has been authorized by the Chief of Engineers.

Section 13 Section 13 (Title 33, USC Section 407) states that the Secretary of the Army may permit the discharge of refuse into navigable waters if the Chief of Engineers has determined that the discharge will not injure anchorage and navigation. Discharges of refuse are prohibited unless a permit has been obtained. Although the prohibition in this section – known as the Refuse Act – is still in effect, the Secretary of the Army's permit authority has been superseded by the permit authority given to the EPA Administrator and the states under Sections 402 and 405 of the CWA, respectively.

Safe Drinking Water Act

The Safe Drinking Water Act mandates that EPA establish regulations to protect human health from contaminants in drinking water. This law authorizes EPA to develop national standards for drinking water and to create a joint Federal/state/tribal system to ensure compliance with these standards. The law also directs EPA to protect underground sources of drinking water by controlling the underground injection of liquid wastes.

EPA has developed primary and secondary drinking water standards under its Safe Drinking Water Act authority. EPA and authorized states and tribes enforce the primary drinking water standards, which are contaminant-specific concentration limits that apply to certain public supplies of drinking water. The primary standards consist of two elements: goals for maximum contaminant levels, which are nonenforceable health-based goals; and maximum contaminant levels, which are enforceable limits set as close to the maximum contaminant level goals as possible, considering the cost and feasibility of attainment.

Federal Water Project Recreation Act

The Federal Water Project Recreation Act requires that Federal agencies with authority to approve water projects include recreation development as a condition of approving permits. Recreation development must be considered along with any navigation, flood control, reclamation, hydroelectric, or multipurpose water resource project. The act states that "consideration shall be given to the opportunities, if any, which the project affords for outdoor recreation and for fish and wildlife enhancement…wherever any such project can reasonably serve either or both of these purposes consistently" (Title 16, USC Section 460l-12).

Federal Clean Air Act

The Federal Clean Air Act (CAA) was enacted to protect and enhance the nation's air quality to promote public health and welfare and the productive capacity of the nation's population. The CAA requires that Federal actions be evaluated to determine their potential impacts on air quality in the project region. California has a corresponding law, which also must be considered during the EIS/R process.

For specific projects, Federal agencies must coordinate with the appropriate air quality management district and EPA. This coordination determines whether the project conforms to the CAA and the state implementation plan.

Section 176 of the CAA prohibits Federal agencies from engaging in or supporting an action or activity that does not conform to an applicable state implementation plan. Actions and activities must conform to the plan's purposes of eliminating or reducing violations of national ambient air quality standards, reducing the severity of violations, and attaining those standards expeditiously.

National Historic Preservation Act

Section 106 of the National Historic Preservation Act of 1966 and its implementing regulations (Title 36, CFR Part 800, as amended in 2004) requires Federal agencies to consider the effects of their actions, or those they fund or permit, on properties that are listed or eligible for listing in the National Register of Historic Places (NRHP). The NRHP is a register of districts, sites, buildings, structures, and objects of significance in American history, architecture, archaeology, engineering, and culture. The regulations provided in 36 CFR Part 60.4 describe the criteria to evaluate cultural resources for inclusion in the NRHP. Cultural resources can be significant on the national, state, or local level. Properties may be listed in the NRHP if they possess integrity of location, design, setting, materials, workmanship, feeling, and association, and meet any one of the following criteria:

1. Are associated with events that have made a significant contribution to the broad patterns of our history

2. Are associated with the lives of persons significant in our past

3. Embody the distinctive characteristics of a type, period, or method of construction, or represent the work of a master, or possess high artistic values, or represent a significant and distinguishable entity whose components may lack individual distinction

4. Have yielded, or may be likely to yield, information important in prehistory or history

Generally, properties are not considered eligible for the NRHP if they have achieved significance within the past 50 years. Certain exceptions are made in the regulation, such as a religious property deriving primary significance from its architectural distinction, or a grave of a historical figure of outstanding importance if there is no appropriate site directly associated with his productive life.

Native American Graves Protection and Repatriation Act

The Native American Graves Protection and Repatriation Act (Public Law 101-601; 25 United States Code 3001-3013) pertains to Native American burial sites and regulates the removal of human remains, funerary objects, sacred objects, and items of cultural patrimony on Federal and tribal lands. The Act requires permits for intentional removal or excavation of Native American human remains on Federal lands, covers cases of inadvertent discoveries, and dictates the ultimate disposition process of Native American human remains and cultural items.

Archaeological Resources Protection Act

The purpose of the Archaeological Resources Protection Act of 1979 (Public Law 95-96 – October 31, 1979) is to protect archaeological resources and sites that are located on public lands and Indian lands, and to foster increased cooperation between governmental authorities, the professional archaeological community, and private individuals in possession of archaeological resources. The act makes it unlawful to excavate, remove, or deface archaeological resources, to sell, purchase, or exchange those resources without applicable permit, and establishes criminal and civil penalties for any such violation.

Farmland Protection Policy Act

The Farmland Protection Policy Act requires that a Federal agency examine the potential impacts of a proposed action on Prime Farmland and Unique Farmland, as defined by the U.S. Natural Resources Conservation Service. If the action would adversely affect farmland preservation, the Federal agency must consider alternatives to lessen the adverse effects.

Migratory Bird Treaty Act

The Migratory Bird Treaty Act, first enacted in 1918, implements domestically a series of treaties between the United States and Great Britain (on behalf of Canada), Mexico, Japan, and the former Soviet Union that provide international protection of migratory birds. The act authorizes the Secretary of the Interior to regulate the taking of migratory birds. It is unlawful, except as permitted by regulations, "to pursue, take, or kill any migratory bird, or any part, nest or egg of any such bird…" (Title 16, USC Section 703). This prohibition includes both direct and indirect acts, although harassment and habitat modification are not included unless they result in the direct loss of birds, nests, or eggs. Several hundred species, essentially including all native birds, are currently protected by the Migratory Bird Treaty Act. The act offers no statutory or regulatory mechanism for obtaining an incidental take permit for the loss of nongame migratory birds.

Bald and Golden Eagle Protection Act

The Bald and Golden Eagle Protection Act, enacted in 1940 and amended multiple times since, prohibits the taking of bald and golden eagles without a permit from the Secretary of the Interior. Similar to the ESA, the Bald and Golden Eagle Protection Act defines "take" to include "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb" (Title 16, USC Sections 668-668c). Any disturbance that would injure an eagle, decrease productivity, or cause nest abandonment – including habitat alterations that could have these results – is considered take and can result in civil or criminal penalties.

National Forest Management Act

The National Forest Management Act requires USFS to "provide for a diversity of plant and animal communities" (Title 16, USC Section 1604(g)(3)(B)) as part of its multiple-use mandate. USFS must maintain "viable populations of existing native and desired nonnative species in the planning area" (Title 36, CFR Section 219.19). The Sensitive Species program is designed to meet this mandate and to demonstrate USFS's commitment to maintaining biodiversity on National Forest System lands.

A key requirement of the National Forest Management Act is preparation of land and resource management plans that establish the goals, objectives, and standards and guidelines for managing the lands and resources of National Forest System lands managed by the various National Forests.

Federal Land Policy and Management Act

Sections 201 and 202 of the Federal Land Policy and Management Act of 1976 (FLPMA) (Title 43, USC Sections 1711–1712) and the regulations in Title 43, CFR Section 1600 provide guidance and direction for implementing BLM's land use planning requirements, as established by resource management plans. Resource management plans and subsequent planning decisions are the basis for every on-the-ground action undertaken by BLM.

Resource management plans ensure that public lands are managed in accordance with the intent of Congress as stated in the FLPMA, under the principles of multiple use and sustained yield. As required by the FLPMA and BLM policy, public lands must be managed in a manner that will do all of the following:

- Protect the quality of ecological and scientific values
- Preserve and protect certain public lands in their natural condition, where appropriate
- Provide food and habitat for fish and wildlife and domestic animals
- Provide for outdoor recreation and human occupancy and use
- Recognize the nation’s need for domestic sources of minerals, food, timber, and fiber from the public lands by encouraging collaboration and public participation throughout the planning process

Resource management plans are among the primary mechanisms for guiding BLM activities to achieve compliance with the FLPMA.

Federal Wild and Scenic Rivers Act

The Federal Wild and Scenic Rivers Act of 1968, as amended (Public Law 90-542; Title 16, USC Sections 1271–1287), established the National Wild and Scenic Rivers System. This system identifies distinguished rivers of the nation that possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values. The Federal Wild and Scenic Rivers Act preserves the free-flowing condition of designated rivers and protects their local environments. Section 5(d)(1) of the act requires Federal agencies to consider potential national wild, scenic, and recreational river areas when planning for the use and development of water and related land resources. Wild, scenic, and recreational river areas are defined as follows:

- *“Wild” river areas* are rivers or sections of rivers that are free of impoundments and generally inaccessible except by trail, with watersheds or shorelines essentially primitive and waters unpolluted. These represent vestiges of primitive America.
- *“Scenic” river areas* are rivers or sections of rivers that are free of impoundments, with shorelines or watersheds still largely primitive and shorelines largely undeveloped, but accessible by roads in places.
- *“Recreational” river areas* are rivers or sections of rivers that are readily accessible by road or railroad, that may have some development along their shorelines, and that may have undergone some impoundment or diversion in the past.

Designation as a National wild and scenic river explicitly prohibits the Federal government from licensing or permitting new hydroelectric dams or major diversions on these rivers. Federal agencies are also prohibited from assisting any water resource projects that may directly affect the resources for which the river was designated. Public lands within a corridor averaging one-quarter mile on both sides of the rivers are managed to protect resources designated as outstandingly remarkable for their scenic, recreational, historical/cultural, fish, wildlife, ecological, geological, or hydrologic value.

Indian Trust Assets

All Federal agencies have a responsibility to protect Indian trust assets. Indian trust assets are legal interests in assets held in trust by the Federal government for Native American tribes or individuals. Assets may be owned property, physical assets, intangible property rights, a lease, or the right to use something. Typically, they include lands, minerals, water rights, hunting and fishing rights, natural resources, money, and claims.

Executive Order 11988 (Flood Hazard Policy)

Executive Order 11988 is a flood hazard policy for all Federal agencies that manage Federal lands, sponsor Federal projects, or provide Federal funds to state or local projects. The order requires that Federal agencies take necessary action to reduce the risk of flood loss; restore and preserve the natural and beneficial values served by floodplains; and minimize the impacts of floods on human safety, health, and welfare.

Executive Order 11990 (Protection of Wetlands)

Executive Order 11990 is an overall wetlands policy for all Federal agencies that manage Federal lands, sponsor Federal projects, or provide Federal funds to state or local projects. The order requires that Federal agencies follow avoidance, mitigation, and preservation procedures with public input before they propose new construction in wetlands. Executive Order 11990 can restrict the sale of Federal land containing wetlands; however, it does not apply to Federal discretionary authority for non-Federal projects (other than funding) on non-Federal land.

Executive Order 12898 (Environmental Justice Policy)

Executive Order 12898 requires Federal agencies to identify and address the disproportionately high and adverse human health and environmental effects of Federal programs, policies, and activities on minority and low-income populations. The requirements of Executive Order 12898 apply to all Federal actions that are located on Federal lands, sponsored by a Federal agency, or funded with Federal monies and may affect minority or low-income populations.

Executive Order 13007 (Indian Sacred Sites) and April 29, 1994, Executive Memorandum

Executive Order 13007 (May 24, 1996) requires Federal agencies with land management responsibilities to accommodate access to and ceremonial use of Indian sacred sites by Indian religious practitioners and avoid adversely affecting the physical integrity of such sacred sites. Where appropriate, agencies are to maintain the confidentiality of sacred sites. Among other things, Federal agencies must provide reasonable notice of proposed actions or land management policies that may restrict future access to or ceremonial use of, or adversely affect the physical integrity of, sacred sites. The agencies must comply with the April 29, 1994, executive memorandum, "Government-to-Government Relations with Native American Tribal Governments."

Executive Order 13112 (National Invasive Species Management Plan)

Executive Order 11312 directs all Federal agencies to prevent and control introductions of invasive nonnative species in a cost-effective and environmentally sound manner to minimize their economic, ecological, and human health impacts. Executive Order 11312 established the national Invasive Species Council, made up of Federal agencies and departments, and the supporting Invasive Species Advisory Committee, composed of state, local, and private entities. The Invasive Species Council and Advisory Committee oversee and facilitate implementation of the executive order, including preparation of a national invasive-species management plan.

Federal Transit Administration

To address the human response to ground-borne vibration, the Federal Transit Administration has set forth guidelines for maximum-acceptable vibration criteria for different types of land uses (FTA 2006):

- 65 vibration decibels for land uses where low ambient vibration is essential for interior operations (e.g., hospitals, high-tech manufacturing, and laboratory facilities)
- 80 vibration decibels for residential uses and buildings where people normally sleep
- 83 vibration decibels for institutional land uses with primarily daytime operations (e.g., schools, churches, clinics, and offices)

Standards have also been established to address the potential for ground-borne vibration to cause structural damage to buildings. These standards were developed by the Committee of Hearing, Bio Acoustics, and Bio Mechanics at the request of EPA (FTA 2006). For fragile structures, this committee recommends a maximum limit of 0.25 inch per second peak particle velocity (FTA 2006). (Peak particle velocity is a measure of the intensity of ground vibration, specifically the time rate of change of the amplitude of ground vibration.)

Federal Land Use Policies

Federal land use policies apply only to actions on or affecting the uses of Federal lands. The following are the Federal lands located in the vicinity of the study area:

- National Forest System lands administered by the Shasta-Trinity National Forest
- Reclamation-owned lands along the Sacramento River, just south of Shasta Dam
- BLM-owned lands along the Sacramento River, just north of Red Bluff

Access to these Federal properties would require approval from these entities.

Shasta-Trinity National Forest Land and Resource Management Plan

The *Shasta-Trinity National Forest Land and Resource Management Plan* was most recently revised in 1995 (USFS 1995). This document is revised every 10–15 years; it supersedes any previous forest plans, timber management plans, or NRA plans. It contains the goals and objectives for Shasta-Trinity National Forest, its standards and guidelines, management prescriptions to be applied to land areas, and management area direction. It also sets forth requirements for monitoring and implementation of the plan. The allocations associated with this plan not only reflect the capability and suitability of the land for various uses, but also respond to the public issues (such as recommendations for wild and scenic river designations) and development opportunities identified during the planning process.

Whiskeytown-Shasta-Trinity National Recreation Area Management Plan

The Whiskeytown-Shasta-Trinity NRA consists of the Shasta and Trinity units on the Shasta-Trinity National Forest (managed by the USFS) and the Whiskeytown Unit located outside the National Forest (managed by the National Park Service).The Whiskeytown-Shasta-Trinity NRA was established on November 8, 1965 with the signing of Public Law 89-336 by President Lyndon Johnson. The legislation provides that administration of the NRA be carried out under separate management plans, and that these plans are to be reviewed and revised periodically. The *Management Guide: Shasta and Trinity Units of the Whiskeytown-Shasta-Trinity NRA* (USFS 2014) provides a general framework to guide management of the Shasta and Trinity Units of the NRA, and by which to evaluate and gauge the appropriate NRA management efforts and analysis. This guide is not a decision document or an assessment under NEPA, and does not implement site-specific projects.

The NRA Guide relies on the Forest Plan for a broad umbrella of direction and is incorporated by reference into the Forest Plan. The periodic updates to the NRA Guide respond to changes in environmental conditions, public concern, and recreation use patterns, providing better management of the resources in the

NRA and continued implementation of the management direction in the Forest Plan.

Redding Resource Management Plan

BLM owns lands along the Sacramento River just north of Red Bluff. This land is managed by BLM in accordance with the *Redding Resource Management Plan*, which covers more than 250,000 acres in north-central California in Butte, Shasta, Siskiyou, Tehama, and Trinity counties. Many Areas of Critical Environmental Concern and national wild and scenic river corridors are included within these easily accessed and heavily used public lands. Completed in 1993, the *Redding Resource Management Plan* primarily addresses recreation, land tenure, access, and forest management.

Federal Energy Regulatory Commission

Changes to hydroelectric facilities on the Pit River – instream flow releases or modifications to downstream structures – may necessitate an amendment to a FERC license. Typical modifications that require an amendment to a license or exemption include capacity changes, design changes, operational changes, land status changes, and time extensions. Before issuing a license amendment, FERC ensures that proposed changes to hydropower facilities comply with NEPA. For noncapacity-related amendments, other factors – the nature of the proposed change, project type (based on proposed capacity), and construction status – determine which items outlined in the FERC Division of Hydropower Administration and Compliance's *Compliance Handbook* to include in the amendment application. If any item in the original license would be modified as a result of the project, a revised version must be filed along with the amendment application.

Once the need for an amendment is determined, the appropriate resource agencies are consulted. The extent of agency consultation depends on whether the amendment is capacity-related or noncapacity-related. After pre-filing consultation is completed, the licensee files the amendment application. The FERC Division of Hydropower Administration and Compliance then determines whether a public notice is warranted and whether NEPA review is required. NEPA review entails preparing an environmental assessment and/or an EIS. The license amendment process is detailed in the *Compliance Handbook.*

3.4.2 State

The section below describes potential State or local agency requirements under CEQA if the preferred alternative or action alternatives is authorized and approved. It is possible that some state or local agencies will be unable to process and issue permits and approvals identified below.

California Environmental Quality Act

Prompted by the passage of NEPA in 1969, CEQA was signed into law in 1970 as California's counterpart to NEPA. CEQA requires State and local agencies to identify the significant environmental impacts of their actions and to avoid or mitigate those impacts, if feasible. The objectives of CEQA are to do all of the following:

- Disclose to decision makers and the public the significant environmental effects of proposed activities
- Identify ways to avoid or reduce environmental damage
- Prevent environmental damage by requiring implementation of feasible alternatives or mitigation measures
- Disclose to the public the reasons for agency approval of projects with significant environmental effects
- Foster interagency coordination in the review of projects
- Enhance public participation in the planning process

California Endangered Species Act

Pursuant to the California Endangered Species Act (CESA), a permit from CDFW is required for projects that could result in the take of a plant or animal species that is State-listed as threatened or endangered. Under the CESA, “take” is defined as an activity that would directly or indirectly kill an individual of a species, but the CESA definition of take does not include “harming” or “harassing,” as the Federal ESA definition does. As a result, the threshold for take is higher under the CESA than under the Federal ESA (i.e., habitat modification is not necessarily considered take under the CESA). However CESA requires full mitigation of effects to listed species, a higher standard than Federal ESA.

Sections 3503 and 3503.5 of the California Fish and Game Code state that it is unlawful to take, possess, or needlessly destroy the nest or eggs of any bird, or to take, possess, or destroy any raptors (i.e., species in the orders Falconiformes and Strigiformes), including their nests or eggs. Destruction of active nests caused by removal of vegetation in which the nests are located is a typical violation of these codes. Violation of Section 3503.5 could also include failure of active raptor nests that results from disturbance of nesting pairs by nearby project construction. This statute does not provide for the issuance of any type of incidental take permit.

California Fish and Game Code – Fully Protected Species

Protection of fully protected species is described in Sections 3511, 4700, 5050, and 5515 of the California Fish and Game Code. These statutes prohibit take or possession of fully protected species. CDFW is unable to authorize incidental take of fully protected species when activities are proposed in areas inhabited by those species. CDFW has informed non-Federal agencies and private parties that they must avoid take of any fully protected species in carrying out projects.

California Fish and Game Code Section 1602 – Streambed Alteration

All diversions, obstructions, or changes to the natural flow or bed, channel, or bank of any river, stream, or lake in California that supports wildlife resources are subject to regulation by CDFW under Section 1602 of the California Fish and Game Code. Under Section 1602, it is unlawful for any person, governmental agency, or public utility to do the following without first notifying CDFW:

> *…substantially divert or obstruct the natural flow of, or substantially change or use any material from the bed, channel, or bank of any river, stream, or lake, or deposit or dispose of debris, waste, or other material containing crumbled, flaked, or ground pavement where it may pass into any river, stream, or lake.*

A stream is defined as a body of water that flows at least periodically or intermittently through a bed or channel that has banks and supports fish or other aquatic life. This definition includes watercourses with a surface or subsurface flow that supports or has supported riparian vegetation. CDFW's jurisdiction within altered or artificial waterways is based on the value of those waterways to fish and wildlife.

California Fish and Game Code Sections 5900–5904, 5930–5948, 7261, and 7370 – Fish Passage

The California Fish and Game Code includes the following provisions intended to protect fish passage:

- *Sections 5900–5904* prohibit constructing or maintaining any device or contrivance in any stream that prevents, impedes, or tends to prevent or impede the passing of fish upstream and downstream.
- *Sections 5930–5948* require CDFW to inspect California's dams to ensure that dam owners are maintaining fish passage. CDFW may require dam owners to install a suitable fishway if passage is impeded.
- *Section 7261* authorizes the California Fish and Game Commission to designate as "Heritage Trout Waters" any waters that provide anglers with an opportunity to catch native trout, consistent with the conservation of the California native trout. The McCloud River redband trout occurs in the McCloud River upstream from McCloud Dam.
- *Section 7370* prohibits taking or possessing for commercial purposes, buying or selling, or offering to buy or sell all or part of any sturgeon,

including its eggs, unless the sturgeon was cultured, taken from another state, or taken pursuant to a sport fishing license. Green sturgeon occurs in the primary and extended study areas in the Sacramento River, its tributaries, and the Delta.

California Water Commission

In November 2009, California enacted a comprehensive water package to improve the state's water supply reliability and restore the Delta ecosystem. The package included the Safe, Clean, and Reliable Drinking Water Supply Act which, if approved by voters in 2014, will direct the California Water Commission to develop tools and methods for the quantification of public benefits of water storage projects including CALFED surface storage, groundwater storage, conjunctive use and reservoir reoperation, and local and regional storage.

Delta Stewardship Council

In November 2009 the Sacramento-San Joaquin Delta Reform Act was passed by the California Legislature and signed by Governor Schwarzenegger. It established state policy of coequal goals for the Delta and created the Delta Stewardship Council as a new, independent state agency that will delineate exactly how to meet these goals through development and implementation of the Delta Plan.

The Council's principal task is to develop and implement the Delta Plan, a legally enforceable document that will include all the actions necessary to ensure the state's coequal goals for the Delta are met (Delta Stewardship Council 2013). The Delta Plan was adopted in May 2013.

Central Valley Flood Protection Board Encroachment Permit

The Central Valley Flood Protection Board (CVFPB) enforces standards for the construction, maintenance, and protection of adopted flood control plans that will protect public lands from floods. The jurisdiction of the CVFPB includes the Central Valley, including all tributaries and distributaries of the Sacramento River, the San Joaquin River, and designated floodways (Title 23, CCR Section 2). The CVFPB has all the responsibilities and authorities necessary to oversee future modifications as approved by USACE pursuant to assurance agreements with USACE and USACE's Operation and Maintenance Manuals under Title 33, CFR Section 208.10 and Title 33, USC Section 408.

The CVFPB, in cooperation with USACE, is responsible for reducing the risk of catastrophic flooding to people and property within the Central Valley. The CVPFB helps preserve the integrity of the existing flood control system and designated floodways through its regulatory authority by issuing permits for encroachments. Construction and habitat restoration projects within the jurisdiction of the CVFPB are required to meet standards for the construction, maintenance, and protection of adopted plans of flood control that will protect public lands from floods. The State, through the CVFPB, shares in the costs of construction, assumes responsibility for ensuring the operation and maintenance of the facilities, and holds the federal government harmless from liability. For the CVFPB's flood management projects, the CVFPB delegates operation and maintenance to DWR, or to local maintaining agencies.

California Water Rights

A water right is a legally granted and protected right to take possession of water and put it to beneficial use. As authorized by the California Water Code, the State Water Board allocates surface water rights and permits the diversion and use of water throughout the state. Through its Division of Water Rights, the State Water Board issues permits to divert water for new appropriations, change existing water rights, or store water for a certain length of time. The State Water Board attaches conditions to these permits to ensure that the water user prevents waste, conserves water, does not infringe on the rights of others, and puts the State's water resources to the most beneficial use in the best interest of the public.

California Public Resources Code

PRC Section 5093.542, established through enactment of the California Wild and Scenic Rivers Act, as amended (Sections 5093.50 through 5093.70), aims to preserve designated rivers that possess extraordinary scenic, recreation, fishery, or wildlife values. With the act's passage, the California system protected segments of the Smith and Klamath rivers and their tributaries, and the Scott, Salmon, Trinity, Eel, Van Duzen, and American rivers. Segments of the McCloud River, Deer Creek, and Mill Creek were subsequently protected under the act in 1989 and 1995, respectively, although these segments were not formally designated as components of the State's Wild and Scenic Rivers System.

No dam, reservoir, diversion, or other water impoundment facility may be constructed on any river segment included in the State system. No water diversion facility may be constructed on any river segment included in the State system unless the Resources Secretary determines that the facility is needed to supply domestic water to local residents and that the facility will not adversely affect the river's free-flowing condition and natural character. In reference to the McCloud River, PRC Section 5093.542(c) states the following:

> *Except for participation by the [California] Department of Water Resources in studies involving the technical and economic feasibility of enlargement of Shasta Dam, no department or agency of the state shall assist or cooperate with, whether by loan, grant, license, or otherwise, any agency of the federal, state, or local government in the planning or construction of any dam, reservoir, diversion, or other water impoundment facility that could have an adverse effect on the free-flowing condition of the McCloud River, or on its wild trout fishery.*

Designation as a wild and scenic river does not affect existing water rights and facilities. Proposed changes in existing rights and facilities or applications for new water rights and facilities on designated segments are subject to the domestic-use restriction and the nondegradation standard. Designated segments are considered fully appropriated streams by the State Water Board.

PRC Section 5093.542 shares similar criteria and definitions in regard to the purpose of protecting rivers with the Federal Wild and Scenic Rivers Act: identifying free-flowing rivers with extraordinary values suitable for protection, establishing a study process to include rivers in the system, and classifying river segments as either wild, scenic, or recreational based largely on the degree of development along each river segment included in the system. The primary purpose of both the Federal Wild and Scenic Rivers Act and the PRC is to prohibit new water impoundments on designated rivers.

The PRC also contains several other sections relevant to the project. Some examples include PRC Section 5096.225 (the California Park and Recreational Facilities Act of 1984), PRC Section 5094 (the Federal Water Project Recreation Act), and the CWA.

California Harbors and Navigation Code

The California Harbors and Navigation Code details the jurisdiction of the California Department of Boating and Waterways, which is focused on the development of public access to waterways, the safety of vessels and boating facilities, and on-the-water safety.

Porter-Cologne Water Quality Control Act

Under the Porter-Cologne Water Quality Control Act, “waters of the State” fall under the jurisdiction of the appropriate regional water quality control board (in this case, the CVRWQCB). Under the act, the regional water quality control board must prepare and periodically update basin plans. Each basin plan sets forth water quality standards for surface water and groundwater, and actions to control nonpoint and point sources of pollution to achieve and maintain these standards. Projects that affect wetlands or waters must meet the regional water quality control board’s waste discharge requirements, which may be issued in addition to a water quality certification under Section 401 of the CWA.

California Land Conservation Act of 1965 (Williamson Act)

The California Land Conservation Act of 1965, commonly known as the Williamson Act, is the principal method for encouraging preservation of agricultural lands in California. The Williamson Act enables local governments to enter into contracts with private landowners that restrict specific parcels of land to agricultural or related open-space use for 10 years. In return, landowners receive property tax assessments that are based on farming and open space uses rather than full market value. Local governments receive an annual subvention (subsidy) of forgone property tax revenues from the State via the Open Space Subvention Act of 1971.

The Williamson Act empowers local governments to establish "agricultural preserves" consisting of lands devoted to agricultural uses and other compatible uses. When establishing such preserves, the locality may offer to owners of included agricultural land the opportunity to enter into annually renewable contracts that restrict the land use for at least 10 years. In return, the landowner is guaranteed a relatively stable tax base, founded on the value of the land for agricultural/open space use only and unaffected by its development potential.

Cancelling a Williamson Act contract requires the landowner to undergo an extensive review and approval process and pay fees of up to 12.5 percent of the property value. The local jurisdiction approving the cancellation must find that the cancellation is consistent with the purpose of the California Land Conservation Act or is in the public interest. Several subfindings must be made to support either finding, as defined in Section 51282 of the California Government Code.

California Clean Air Act

The California Clean Air Act of 1988 requires nonattainment areas to achieve and maintain the State ambient air quality standards by the earliest practicable date. Local air districts must develop plans for attaining the State standards for ozone, carbon monoxide, sulfur dioxide, and nitrogen dioxide.

California Native Plant Protection Act

In addition to the CESA, the California Native Plant Protection Act provides protection to endangered and rare plant species, subspecies, and varieties of wild native plants in California. The definitions of "endangered" and "rare" in the California Native Plant Protection Act closely parallel the CESA definitions of "endangered" and "threatened" plant species.

California Surface Mining and Reclamation Act

The California Surface Mining and Reclamation Act of 1975 (SMARA) (PRC Section 2710 et seq.) addresses surface mining. Among the activities subject to SMARA are the mining of minerals, gravel, and borrow material. SMARA requires mitigation to reduce adverse impacts on public health, property, and the environment. Because the SLWRI may obtain borrow material for project construction from sites not previously permitted, Reclamation must comply with SMARA. SMARA applies to an individual or entity that would disturb more than 1 acre or remove more than 1,000 cubic yards of material through surface mining activities, including the excavation of borrow pits for soil material. SMARA is implemented through permitting ordinances developed by local government "lead agencies" that provide the regulatory framework under which local mining and reclamation activities are conducted. The State Mining and Geology Board reviews the local ordinances to ensure that they meet the procedures established by SMARA.

California Native Plant Society California Rare Plant Ranking System

The California Native Plant Society is a statewide nonprofit organization that seeks to increase understanding of California's native flora and to preserve this resource for future generations. The organization develops and maintains the California Rare Plant Ranking System (formerly known as the California Native Plant Society species lists). Species shown in this system have no formal legal protection, but the values and importance of these lists are widely recognized and these rankings provide the basis for USFS and BLM special-status species lists.

California Scenic Highway Program

The Scenic Highways Element is an optional element of the *California Highway Designs Manual* authorized by Section 65303 of the Government Code. The stated intent (Streets and Highways Code, Section 260) of the California Scenic Highway Program is to protect and enhance California's natural scenic beauty and to protect the social and economic values provided by the state's scenic resources. For a highway to receive official designation, the local jurisdiction must enact a scenic corridor protection program that protects and enhances scenic resources. A properly enforced program can do all of the following:

- Protect against inappropriate land uses
- Mitigate uses that detract from scenic values by proper siting, landscaping, or screening
- Make development more compatible with the environment by requiring building siting, height, colors, and materials that are harmonious with the surroundings
- Regulate grading to cause minimal alteration of existing contours and to preserve important vegetative features along the highway

State Lands Commission Land Use Lease

The California State Lands Commission has the authority and responsibility to manage and protect the important natural and cultural resources on certain public lands in the State and the public's rights to access these lands. Two distinct types of public lands are under the commission's jurisdiction: sovereign lands and school lands. Sovereign lands encompass approximately 4 million acres. These lands include the beds of California's naturally navigable rivers, lakes, and streams, and the state's tidal and submerged lands along the coastline, extending from the shoreline out to 3 miles offshore.

State of California General Plan Guidelines

The State of California has developed land-use compatibility guidelines for community-noise environments. The *State of California General Plan Guidelines*, published by the Governor's Office of Planning and Research (OPR

2003), provides guidance for the acceptability of projects within specific community noise equivalent level/day-night noise level (L_{dn}) contours. With regard to the SLWRI, water recreational uses are considered acceptable in areas where exterior noise levels do not exceed 75 A-weighted decibels community noise equivalent level/L_{dn}. Water recreational uses are normally unacceptable in areas exceeding 70 A-weighted decibels L_{dn} and clearly unacceptable in excess of 80 A-weighted decibels L_{dn}. The guidelines also present adjustment factors that may be used to arrive at noise-acceptability standards that reflect the particular community's noise-control goals, sensitivity to noise, and assessment of the relative importance of noise issues.

California Department of Transportation

Caltrans recommends vibration thresholds of 0.2 inch per second peak particle velocity for normal residential buildings and 0.08 inch per second peak particle velocity for old or historically significant structures (Caltrans 2002). These standards are more stringent than the Federal standard established by the Committee of Hearing, Bio Acoustics, and Bio Mechanics, presented above under "Federal Transit Administration."

Caltrans is responsible for planning, designing, construction, operating, and maintaining all State-owned roadways in California. The *Caltrans Highway Design Manual* establishes uniform policies and procedures to carry out Caltrans's highway design functions. The highway design criteria and policies in the manual provide a guide for applying standards in the design of projects and, rather than implementing enforceable regulations, present information and guidance.

3.4.3 Regional and Local

Shasta County Air Quality Management District's Authority to Construct and Permit to Operate

Facilities with equipment that may emit air pollution or would be used for controlling air pollution are subject to SCAQMD permit requirements. SCAQMD grants two types of permits: Authority to Construct and Permit to Operate. An Authority to Construct permit must be obtained before building or installing a new emissions unit or modifying an existing emissions unit that requires a permit. A Permit to Operate is issued after all construction is completed and the emission unit is ready for operation.

Other Local Permits and Requirements

Several other local permits and requirements may apply to the SLWRI. Shasta and Tehama counties and their public works departments will require compliance with local plans and ordinances, such as the county general plan, zoning ordinances, grading plan, and various use permits. Utility easements and various encroachments also may be required.

This page left blank intentionally.

Chapter 4 Geology, Geomorphology, Minerals, and Soils

The evaluation in this chapter is based on a review of existing literature and data, along with information obtained from shoreline erosion surveys, wetland delineations, and geotechnical investigations and surveys. The information included in the technical analysis is also derived from the following sources:

- CALFED Bay-Delta Program Final Programmatic EIS/EIR (CALFED 2000a)

4.1 Affected Environment

This section describes the affected environment related to geology, seismicity, soils/erosion, mineral resources, and geomorphology for the dam and reservoir modifications proposed under SLWRI action alternatives. For a more in-depth description, see the *Geologic Technical Report.*

The environmental setting for the geology, seismicity, soils/erosion, mineral resources, and geomorphology assessment of the Shasta Lake and vicinity portion of the primary study area comprises the watersheds draining to Shasta Lake and the land area forming the shoreline of Shasta Lake. Five major drainages flow into Shasta Lake and form “arms” of the lake: Big Backbone Creek, the Sacramento River, the McCloud River, Squaw Creek, and the Pit River. This section also refers to the East and West “arms” of the Main Body of Shasta Lake as Main Body East Arm and Main Body West Arm.

4.1.1 Geology

The geology of the study area is described below for both the primary and extended study areas. The bedrock geology of the study area is described in the following paragraphs. The boundaries of geomorphic provinces referenced in Section 4.1.1 are shown in Figure 4-1.

Shasta Lake and Vicinity

The Shasta Lake and vicinity portion of the primary study area is illustrated in Figure 4-2. The drainages contributing to Shasta Lake cover a broad expanse of land with a widely diverse and complicated geology. Shasta Lake is situated geographically at the interface between the Central Valley, Klamath Mountains, and Modoc Plateau and Cascades geomorphic provinces.

The bedrock geology for the Shasta Lake and vicinity area is shown in Figure 4-3. The mapping legend that accompanies Figure 4-3 is presented in Table 4-1. Shasta Lake itself and adjacent lands (i.e., Shasta Lake and vicinity) are underlain by rocks of the Klamath Mountains and, to a much more limited extent, the Modoc Plateau and Cascades geomorphic provinces. The regional topography is highly dissected, consisting predominantly of ridges and canyons with vertical relief ranging from the surface of Shasta Lake at 1,070 feet above mean sea level (msl) to ridges and promontories more than 6,000 feet above msl. This diversity in topography is primarily a result of the structural and erosional characteristics of rock units in the Shasta Lake and vicinity area.

Klamath Mountains Geomorphic Province The Klamath Mountains Geomorphic Province is located in northwestern California between the Coast Ranges on the west and the Cascade Range on the east. The province consists of Paleozoic meta-sedimentary and meta-volcanic rocks and Mesozoic igneous rocks that make up four individual geologic terranes, also known as belts, extending to the north into southwestern Oregon: the eastern Klamath belt (also known as the eastern Paleozoic belt), central metamorphic belt, western Paleozoic and Triassic belt, and western Jurassic belt (Snoke and Barnes 2008; Hildbrande 2013). The four belts are the remnants of a chain of submarine volcanic mountains folded and faulted against the North American tectonic plate during the Mesozoic era (Heller and Ryberg 1983, Orr et al. 1992, Orr and Orr 1996). Low-angle thrust faults occur between the belts and allow the eastern blocks to be pushed westward and upward. The central metamorphic belt consists of Paleozoic hornblende, mica schists, and ultramafic rocks. The western Paleozoic and Triassic belt, and the western Jurassic belt consist of slightly metamorphosed sedimentary and volcanic rocks.

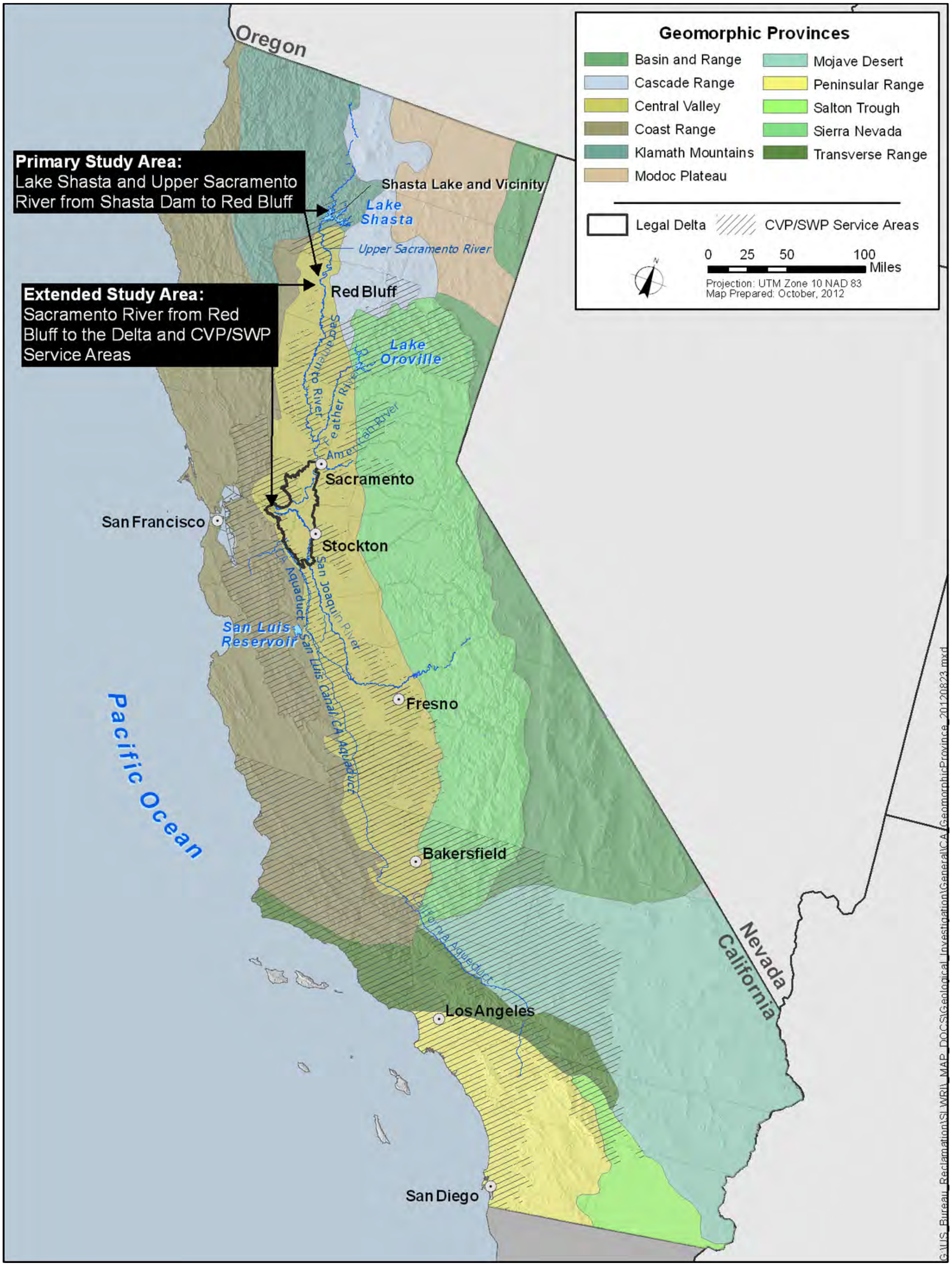


Figure 4-1. Geomorphic Provinces of California

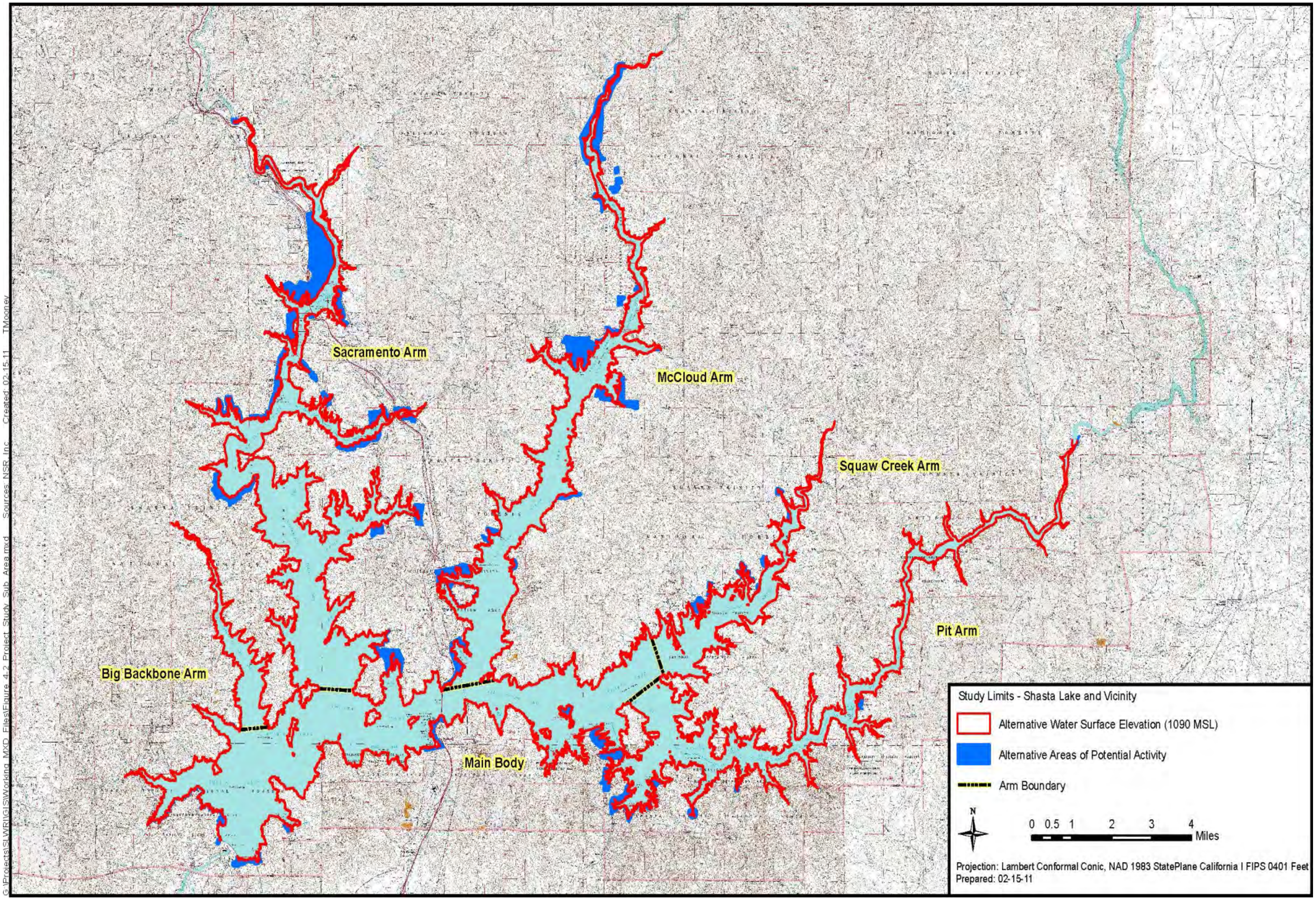


Figure 4-2. Shasta Lake and Vicinity Portion of the Primary Study Area

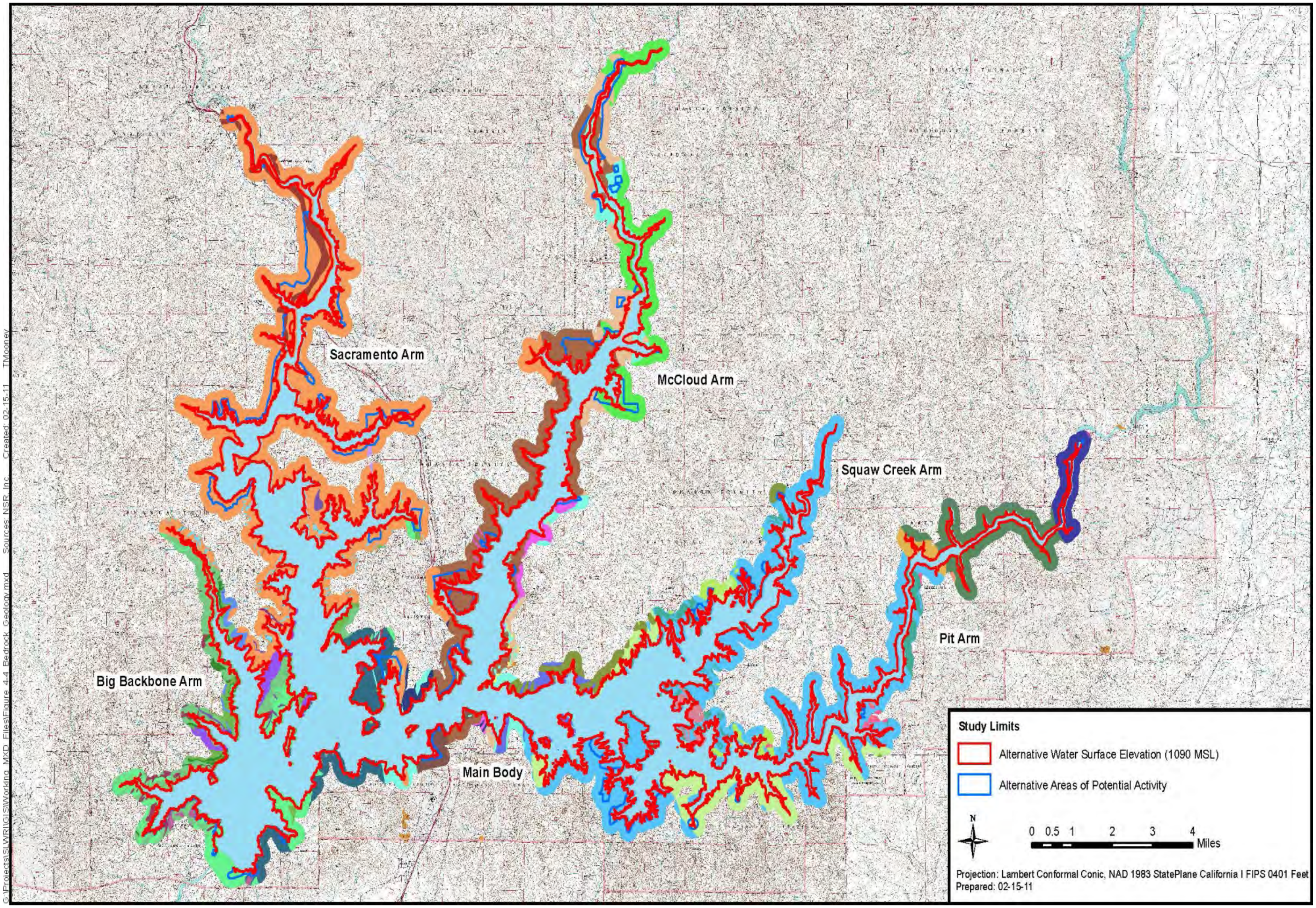


Figure 4-3. Bedrock Geology – Shasta Lake and Vicinity

Table 4-1. Key to Bedrock Geology Map Units – Shasta Lake and Vicinity

Map Unit, Formation, Description
Cb, Baird, meta-pyroclastic & keratophyre; & undiff.
Cbg, Bragdon, shale; graywacke; minor conglomerate
Cbgcp, Bragdon, chert-pebble & quartz conglomerate
Cbgp, Bragdon, pyroclastic; tuff; tuffaceous sediments
Cbgs, Bragdon, black siliceous shale
Cblss, Baird, skarn; lime silicate minerals; magnetite; locally
Cbmv, Baird, greenstone & greenstone breccia
Cbp, Baird, mafic pyroclastic rocks w/ minor tuffaceous mudsto
Db, Balaklala rhyolite, non-porphyritic & with small quartz phenocrysts (1
Dbc, Balaklala rhyolite, porphyritic with large quartz phenocrysts [>4 mm];
Dbp, Balaklala rhyolite, volcanic breccia; tuff breccia; volcanic conglomer
Dbt, Balaklala rhyolite, tuff & tuffaceous shale
Dc, Copley, greenstone; & undiff.
Dct, Copley, greenstone tuff & breccia; shaly tuff & shale
Dk, Kennett, siliceous shale & rhyolitic tuff; & undiff.
Dkls, Kennett, limestone
Dkt, Kennett, tuff; tuffaceous shale; shale
EHaev, , Andesite of Everitt Hill
Ja, Arvison, volcaniclastic & pyroclastic; & undiff.
Jp, Potem, argillite & tuffaceous sandstone; & undiff.
Pmbh, Bully Hill rhyolit, meta-andesite (quartz keratophyre); meta-dacite; p
Pmbhp, Bully Hill rhyolit, pyroclastic; tuff & tuff breccia
Pmd, , quartz diorite; albite - two pyroxene qd; mafic qd
Pmdk, Dekkas, mafic flows & tuff with minor mudstone & tuffaceou
Pmdkp, Dekkas, breccia; tuff; tuff breccia
Pmml, McCloud, limestone
Pmmls, McCloud, skarn; lime silicate minerals; magnetite; locally
Pmn, Nosoni, tuffaceous mudstone w/ lesser mafic flows; sandsto
Pmpr, Pit River stock, quartz diorite; granodiorite & plagiogranite; 261
Trh, Hosselkus Limeston, limestone; thin-bedded to massive; gray; fossilife
Trm, Modin, andesitic volcaniclastic & pyroclastic rocks; cong
Trp, Pit, shale; siltstone; metavolcanic; w/ limestone; & un
Trpmv, Pit, meta-andesite; meta-dacite; porphyritic & non-; ma
Trpp, Pit, pyroclastic; tuff & tuff breccia
Tt, Tuscan Formation, undivided: volcaniclastic; lahars; tuff; sandston
Tva, Western Cascades, andesite
Tvb, Western Cascades, basalt
di, , intermediate dikes
dia, , diabase dikes & small intrusive bodies
dpp, , plagioclase (+/- hornblende; quartz) porphyritic d
lake, , Shasta Lake; et al

A large portion of the Shasta Lake and vicinity area is underlain by rocks of the eastern Klamath belt. The strata of the eastern belt constitute a column 40,000–50,000 feet thick, and represent the time from the Ordovician period (about 490 million years before present) to the Jurassic period (about 145 million years before present). The stratigraphic column of formations that compose the eastern Klamath belt, including a scale of geologic time, is shown in Table 4-2 (Hackel 1966). Important eastern belt rocks that underlie Shasta Lake and vicinity include metavolcanics of Devonian age (i.e., Copley Greenstone and Balaklala Rhyolite formations), metasedimentary rocks of Mississippian age (i.e., Bragdon Formation), thin-bedded to massive sedimentary rocks of Permian age (i.e., McCloud Limestone Formation), and metasedimentary and metavolcanic rocks of Triassic age (i.e., Pit, Modin, and Bully Hill Rhyolite formations) (Reclamation 2009). Intrusive igneous rocks (e.g., localized granitic bodies) make up fewer than 5 percent of the rocks in the area but are well represented on the Shasta Lake shoreline, particularly in the south-central area of the lake. Mesozoic intrusive dikes are scattered in the western portion of the map area.

Table 4-2. Stratigraphic Column of Formations of the Eastern Klamath Belt

Period/Age Before Present (million years)	Formation	Thickness (feet)	General Features
Jurassic (145–200)	Potem Formation	1,000	Argillite and tuffaceous sandstones, with minor beds of conglomerate, pyroclastics, and limestone.
	Bagley Andesite	700	Andesitic flows and pyroclastics.
	Arvison Formation of Sanborn (1953)	5,090	Interbedded volcanic breccia, conglomerate, tuff, and minor andesitic lava flows.
Triassic (200–250)	Modin Formation	5,500	Basal member of volcanic conglomerate, breccia, tuff, and porphyry, with limestone fragments from the Hosselkus formation.
	Brock Shale	400	Dark massive argillite interlayered with tuff or tuffaceous sandstone.
	Hosselkus Limestone	0–250	Thin-bedded to massive light-gray limestone.
	Pit Formation	2,000–4,400	Predominantly dark shale and siltstone, with abundant lenses of metadacite and quartz-keratophyre tuffs.
	Bully Hill Rhyolite	100–2,500	Lava flows and pyroclastic rocks, with subordinate hypabyssal intrusive bodies.
Permian (250–300)	Dekkas Andesite	1,000–3,500	Chiefly fragmental lava and pyroclastic rocks, but includes mudstone and tuffaceous sandstone.
	Nosoni Formation	0–2,000	Mudstone and fine-grained tuff, with minor coarse mafic pyroclastic rocks and lava.
	McCloud Limestone	0–2,500	Thin-bedded to massive light-gray limestone, with local beds and nodules of chert.

Table 4-2. Stratigraphic Column of Formations of the Eastern Klamath Belt (contd.)

Period/Age Before Present (million years)	Formation	Thickness (feet)	General Features
Carboniferous (300–360)	Baird Formation	3,000–5,000	Pyroclastic rocks, mudstone, and keratophyre flows in lower part; siliceous mudstone, with minor limestone, chert, and tuff in middle part; and greenstone, quartz, keratophyre, and mafic pyroclastic rocks and flow breccia in upper part.
	Bragdon Formation	6,000±	Interbedded shale and sandstone, with grit and chert-pebble conglomerate abundant in upper part.
Devonian (360–420)	Kennett Formation	0–400	Dark, thin-bedded, siliceous mudstone and tuff.
	Balaklala Rhyolite	0–3,500	Light-colored quartz-keratophyre flows and pyroclastics.
	Copley Greenstone	3,700+	Keratophyric and spilitic pillow lavas and pyroclastic rocks.
Silurian (420–450)	Gazelle Formation	2,400+	Siliceous graywackes, mudstone, chert-pebble conglomerate, tuff, and limestone.
Ordovician (450–490)	Duzel Formation	1,250+	Thinly layered phyllitic greywacke, locally with radiolarian chert and limestone.

The McCloud Limestone is prominently exposed within the McCloud, Pit, Main Body, and Big Backbone arms of Shasta Lake. Within the lake footprint, the McCloud Arm has the largest exposure of this limestone, followed by the Pit, Main Body, and Big Backbone arms. Along the McCloud Arm, this limestone crops out on the eastern shore from the mouth at the main body of the lake to Hirz Bay. Above Hirz Bay, it is intermittently exposed on both sides of the McCloud Arm. Along the Pit Arm near the mouth of Brock Creek, the McCloud Limestone is exposed along the northern and southern banks. The McCloud Limestone is exposed near the southern shore of Allie Cove in the eastern portion of the Main Body of the lake. Along the Big Backbone Arm, the McCloud Limestone is exposed near the eastern shore between the outlets of Shoemaker and Limerock creeks. Outside the Shasta Lake footprint, an outcrop of the McCloud Limestone is exposed along the McCloud River approximately 10 miles upstream from the mouth into the McCloud Arm. The McCloud Limestone is also exposed on the north side of Bohemotash Mountain, which is approximately 2 miles from the mouth of Big Backbone Creek at the Big Backbone Arm.

“Skarn” is a geologic term that refers to metamorphic rocks formed in the contact zone of magmatic intrusions (e.g., granite) with carbonate-rich rocks (e.g., limestone). Skarn deposits are rich in lime-silicate minerals and locally contain magnetite. Permian-aged skarn deposits are present within the McCloud Arm. The deposits are located near the mouths of Marble and Potter creeks and on the peninsula at the eastern margin of the inlet of the McCloud Arm. The skarn deposits occur adjacent to the McCloud Limestone at the mouths of Marble and Potter creeks, but the McCloud Limestone is absent near skarn deposits on the peninsula.

A small area of the fossiliferous Cretaceous Chico Formation, consisting of Great Valley marine sedimentary rocks, occurs near Jones Valley Creek, a tributary to the Pit Arm. Although this rock unit occurs in the immediate vicinity, it is not exposed along the shoreline of the lake and falls outside the Shasta Lake and vicinity area. Some outcrops of McCloud Limestone, especially in the vicinity of the McCloud River Bridge, are also fossiliferous. The fossiliferous deposits exposed at these locations are invertebrates, primarily plants, corrals, and mollusks.

Modoc Plateau and Cascades Geomorphic Provinces The Cascade Range and Modoc Plateau together cover approximately 13,000 square miles in the northeast corner of California. The Cascade Range and Modoc Plateau (collectively the Modoc Plateau and Cascades Geomorphic Province) are very similar geologically and consist of young volcanic rocks that are of Miocene to Pleistocene age. Included in this province are two stratovolcanoes, Mount Shasta and Lassen Peak, and the Medicine Lake Highlands, a broad shield volcano.

The Cascade volcanics have been divided into the Western Cascade series and the High Cascade series. The Western Cascade series rocks consist of Miocene-aged basalt, andesite, and dacite flows interlayered with rocks of explosive origin, including rhyolite tuff, volcanic breccia, and agglomerate. This series is exposed at the surface in a belt 15 miles wide and 50 miles long from the Oregon border to the town of Mount Shasta. After a short period of uplift and erosion that extended into the Pliocene, volcanism resumed, creating the High Cascade volcanic series. The High Cascade volcanic series forms a belt 40 miles wide and 150 miles long just east of the Western Cascade series rocks. Early High Cascade rocks formed from very fluid basalt and andesite that extruded from fissures to form low shield volcanoes. Later eruptions during the Pleistocene contained more silica, causing more violent eruptions. Large stratovolcanoes like Mount Shasta and Lassen Peak had their origins during the Pleistocene (Norris and Webb 1990).

The Modoc Plateau consists of a high plain of irregular volcanic rocks of basaltic origin. The numerous shield volcanoes and extensive faulting on the plateau give the area more relief than otherwise may be expected for a plateau. The Modoc Plateau averages 4,500 feet in elevation and is considered a small part of the Columbia Plateau, which covers extensive areas of Oregon, Washington, and Idaho.

Volcanic rocks of the Modoc Plateau and Cascades Geomorphic Province are present adjacent to the eastern and northeastern boundaries of the Shasta Lake and vicinity area. In the vicinity of Shasta Lake they occur near the Pit Arm and along the upper reaches of the Sacramento Arm. These rocks are generally younger than 4 million years old. Volcaniclastic rocks, mudflows, and tuffs of the Tuscan Formation occur in the Pit River area, and localized volcanic deposits occur in isolated locations.

The areal extent of bedrock types within the Shasta Lake and vicinity area is presented in Table 4-3 for the portion of the area between 1,070 feet and 1,090 feet above msl (i.e., Impoundment Area), and in Table 4-4 for the portion potentially disturbed by construction activities (i.e., Relocation Areas).

Table 4-3. Areal Extent of Bedrock Types – Shasta Lake and Vicinity (Impoundment Area)

Map Unit	Formation	Bedrock Types	Acres	% of Total Impoundment Area
Cb	Baird	Meta-pyroclastic and keratophyre	145.3	5.82%
Cbg	Bragdon	Shale; graywacke; minor conglomerate	468.9	18.77%
Cbgcp	Bragdon	Chert-pebble and quartz conglomerate	3.3	0.13%
Cbgs	Bragdon	Black siliceous shale	0.0	0.00%
Cblss	Baird	Skarn	1.2	0.05%
Cbmv	Baird	Greenstone and greenstone breccia	6.7	0.27%
Cbp	Baird	Mafic pyroclastic rocks	4.8	0.19%
Db	Balaklala rhyolite	Rhyolite with non-porphyritic texture including small quartz phenocrysts	52.8	2.11%
Dbc	Balaklala rhyolite	Rhyolite with porphyritic texture including large quartz phenocrysts	3.3	0.13%
Dbp	Balaklala rhyolite	Volcanic breccia; tuff breccia; volcanic conglomerate	12.9	0.52%
Dbt	Balaklala rhyolite	Tuff and tuffaceous shale	5.9	0.24%
Dc	Copley	Greenstone and undiff.	48.9	1.96%
Dct	Copley	Greenstone tuff & breccia	33.4	1.34%
di		Intermediate dikes	0.6	0.02%
dia		Diabase dikes	0.2	0.01%
Dk	Kennett	Siliceous shale and rhyolitic tuff	20.0	0.80%
Dkls	Kennett	Limestone	1.9	0.07%
Dkt	Kennett	Tuff; tuffaceous shale; shale	11.2	0.45%
dpp		Plagioclase-rich diabase dikes	0.7	0.03%
Ehaev		Andesite	17.9	0.72%
Ja	Arvison	Volcaniclastic and pyroclastic	9.6	0.38%
lake	Shasta Lake		924.0	36.99%
Pmbh	Bully Hill rhyolite	Meta-andesite	84.6	3.39%

Table 4-3. Areal Extent of Bedrock Types – Shasta Lake and Vicinity (Impoundment Area) (contd.)

Map Unit	Formation	Bedrock Types	Acres	% of Total Impoundment Area
Pmbhp	Bully Hill rhyolite	Pyroclastic; tuff & tuff breccia	11.0	0.44%
Pmd		Quartz diorite	47.5	1.90%
Pmdk	Dekkas	Mafic flows and tuff	18.9	0.76%
Pmdkp	Dekkas	Breccia; tuff; tuff breccia	16.7	0.67%
Pmml	McCloud	Limestone	26.7	1.07%
Pmmls	McCloud	Skarn	2.2	0.09%
Pmn	Nosoni	Tuffaceous mudstone	66.4	2.66%
Pmpr	Pit River Stock	Quartz diorite; granodiorite	11.2	0.45%
Trh	Hosselkus Limestone	Limestone	7.5	0.30%
Trm	Modin	Andesitic volcaniclastic and pyroclastic rocks	27.9	1.12%
Trp	Pit	Shale; siltstone; metavolcanic; with limestone	374.8	15.00%
Trpmv	Pit	Meta-andesite; meta-dacite	12.0	0.48%
Trpp	Pit	Pyroclastic; tuff and tuff breccia	16.6	0.66%
Tva	Western Cascades	Andesite	0.5	0.02%

Table 4-4. Areal Extent of Bedrock Types – Shasta Lake and Vicinity (Relocation Areas)

Map Unit	Formation	Bedrock Types	Acres	% of Total Relocation Area
Cb	Baird	Meta-pyroclastic and keratophyre	530.8	15.90%
Cbg	Bragdon	Shale; graywacke; minor conglomerate	1,088.4	32.59%
Cbgcp	Bragdon	Chert-pebble and quartz conglomerate	0.6	0.02%
Cbmv	Baird	Greenstone & greenstone breccia	25.6	0.77%
Db	Balaklala rhyolite	Rhyolite with non-porphyritic texture including small quartz phenocrysts	9.8	0.29%
Dbc	Balaklala rhyolite	Rhyolite with porphyritic texture including large quartz phenocrysts	7.8	0.23%
Dbp	Balaklala rhyolite	Volcanic breccia; tuff breccia; volcanic conglomerate	3.9	0.12%
Dbt	Balaklala rhyolite	Tuff and tuffaceous shale	1.1	0.03%
Dc	Copley	Greenstone and undiff.	61.5	1.84%
Dct	Copley	Greenstone tuff and breccia	84.9	2.54%

Table 4-4. Areal Extent of Bedrock Types – Shasta Lake and Vicinity (Relocation Areas) (contd.)

Map Unit	Formation	Bedrock Types	Acres	% of Total Relocation Area
Dk	Kennett	Siliceous shale and rhyolitic tuff	10.3	0.31%
Dkls	Kennett	Limestone	0.4	0.01%
Dkt	Kennett	Tuff; tuffaceous shale; shale	0.0	0.00%
Ehaev		Andesite	261.4	7.83%
Ja	Arvison	Volcaniclastic and pyroclastic	0.7	0.02%
lake	Shasta Lake		242.0	7.25%
Pmbh	Bully Hill rhyolite	Meta-andesite	53.0	1.59%
Pmbhp	Bully Hill rhyolite	Pyroclastic; tuff and tuff breccia	7.5	0.22%
Pmd		Quartz diorite	100.5	3.01%
Pmdk	Dekkas	Mafic flows and tuff	8.8	0.26%
Pmdkp	Dekkas	Breccia; tuff; tuff breccia	18.5	0.55%
Pmml	McCloud	Limestone	174.9	5.24%
Pmn	Nosoni	Tuffaceous mudstone	182.5	5.46%
Pmpr	Pit River Stock	Quartz diorite; granodiorite	42.8	1.28%
Trp	Pit	Shale; siltstone; metavolcanic; wi limestone	408.5	12.23%
Trpp	Pit	Pyroclastic; tuff and tuff breccia	11.5	0.34%
Tva	Western Cascades	Andesite	2.0	0.06%

Cave and Karst Resources

Karst geomorphology is named after the Karst region in Slovenia, where limestone has been geologically carved into world-famous caves and other karst landforms. Caves and karst landforms are found along the Big Backbone Arm, the McCloud Arm, and the Pit Arm (Brock Creek).

Nine caves in the National Recreation Area (NRA) adjacent to Shasta Lake—Dekkas Rock Staircase Cave, Lake Level Cave, Clay Doe Cave, Jolly Time Cave, Blanchet Cave, two caves known as the McCloud Bridge Caves, and two caves known as the Town Mountain Caves—could be periodically inundated under the action alternatives (USFS 2012). The first three of these caves are registered under the Federal Cave Resource Protection Act of 1988. Dekkas Rock Staircase and the two McCloud Bridge caves are already periodically inundated under the current elevation of the dam. Field investigations performed to date have not identified any other caves that would be affected by the raising of Shasta Dam.

Upper Sacramento River (Shasta Dam to Red Bluff)

The portion of the study area along the Sacramento River downstream to the Red Bluff Pumping Plant encompasses portions of the Cascade Range, Klamath Mountains, and Central Valley Geomorphic Provinces.

Central Valley Geomorphic Province The Central Valley Geomorphic Province is a large, asymmetrical, northwest-trending, structural trough formed between the uplands of the California Coast Ranges to the west and the Sierra Nevada to the east, and is approximately 400 miles long and 50 miles wide (Page 1985). The Coast Ranges to the west consist of pre-Tertiary and Tertiary semiconsolidated to consolidated marine sedimentary rocks, volcanic rocks, and exposed uplifted oceanic rocks of the Franciscan Complex. The Coast Ranges sediments are folded and faulted and extend eastward beneath most of the Central Valley. The Sierra Nevada to the east side of the valley is composed of pre-Tertiary igneous and metamorphic rocks overlain by Tertiary volcanic and sedimentary rocks.

Along the western side of the Sacramento Valley, rocks of the Central Valley Geomorphic Province include Upper Jurassic to Cretaceous marine sedimentary rocks of the Great Valley Sequence; fluvial deposits of the Tertiary Tehama Formation; Quaternary Red Bluff, Riverbank, and Modesto Formations; and Recent alluvium.

The Great Valley Sequence was formed from sediments deposited within a trough formed between the Sierra Nevada volcanic arc and the uplifted oceanic crust now known as the Franciscan Complex in the Coast Ranges. A majority of the sediments in this trough were coalescing submarine fans. The sediment sources were the Klamath Mountains and Sierra Nevada to the north and east. These deposits include mudstones, sandstones, and conglomerates.

Tertiary and Quaternary fluvial sedimentary deposits unconformably overlie the Great Valley Sequence. The Pliocene Tehama Formation is the oldest, derived from erosion of the Coast Ranges and Klamath Mountains, and consists of pale green to tan semiconsolidated silt, clay, sand, and gravel. Along the western margin of the valley, the Tehama Formation is generally thin, discontinuous, and deeply weathered.

The Red Bluff Formation is a broad erosional surface, or pediment, of low relief formed on the Tehama Formation between 0.45 and 1.0 million years ago. Thickness varies to about 30 feet.

Recent alluvium consists of loose sedimentary deposits of clay, silt, sand, gravel, and boulders. The deposits may originate from landslides, colluvium, stream channel deposits, and floodplain deposits. Landslides occur along the project area but are generally small, shallow debris slides or debris flows.

Stream channel deposits generally consist of unconsolidated sand and gravel, with minor amounts of silt and clay. Floodplain deposits are finer grained and consist almost entirely of silt and clay (DWR 2003).

Lower Sacramento River and Delta

The study area along the lower Sacramento River and the Delta encompasses the Central Valley Geomorphic Province, as described above for the upper Sacramento River portion of the primary study area.

The Delta is a broad depression in the Franciscan Complex bedrock that resulted from an east-west expansion of the San Andreas and Hayward fault systems, filled by sediments deposited over many millions of years via the Sacramento and San Joaquin rivers and other tributary rivers and streams.

CVP/SWP Service Areas

The CVP/SWP service areas encompass portions of the Central Valley, Sierra Nevada, Coast Ranges, Cascade Range, Peninsular Ranges, Transverse Ranges, Mojave Desert, Modoc Plateau, and Klamath Mountains geomorphic provinces.

The south-of-Delta CVP/SWP service areas include two distinct, noncontiguous areas. In the north are the San Felipe Division's CVP service area and the South Bay SWP service area; to the south are the SWP service areas. The northern section of this region encompasses the Coast Ranges Geomorphic Province and the southern portion of this section includes portions of the Peninsular Ranges, Transverse Ranges, and Mojave Desert geomorphic provinces. Additional information on the geomorphic provinces is available in the *Geologic Technical Report*.

4.1.2 Geologic Hazards

Geologic hazards are described below for both the primary and extended study areas.

Shasta Lake and Vicinity

Six types of geologic hazards have the potential to occur within and near the Shasta Lake and vicinity portion of the primary study area: seismic hazards, volcanic eruptions and associated hazards, mudflows, snow avalanches, slope instability, and seiches.

Seismic Hazards Seismic hazards consist of the effects of ground shaking and surface rupture along and around the trace of an active fault. Ground shaking is the most hazardous effect of earthquakes because it is the most widespread and accompanies all earthquakes. Ground shaking can range from high to low intensity and is often responsible for structural failure, leading to the largest loss of life and property damage during an earthquake. The Modified Mercalli intensity ratings reflect the relationship between earthquake magnitudes and shaking intensity. Higher magnitude earthquakes typically produce higher shaking intensities over wider areas, which may result in greater damage.

Surface rupture occurs when an earthquake results in ground rupture, causing horizontal and/or vertical displacement. Surface rupture typically is narrow in rock and wider in saturated soils, and also typically tends to occur along previous fault lines.

An active fault is defined by the Alquist-Priolo Earthquake Fault Zoning Act (Alquist-Priolo Act) as a fault that has caused surface rupture within the last 11,000 years. According to the California Geological Survey's Alquist-Priolo Act Active Fault Maps, the nearest active fault north of the Shasta Lake and vicinity area is the Hat Creek–Mayfield–McArthur Fault Zone, located about 50 miles to the northeast of Shasta Dam (Jennings 1975). Blakeslee and Katterhorn (2013) refer to the three fault zones as the Hat Creek fault system. The Hat Creek fault system can be readily seen electronically on the California Geological Survey Web site: http://www.quake.ca.gov/gmaps/WH/ regulatorymaps.htm using "Shasta" in the search query. This fault system is composed of numerous parallel north-northwest–trending normal faults. According to the Alquist-Priolo Act maps, the Hat Creek–Mayfield–McArthur fault is capable of generating magnitude 7.0 earthquakes with a return period of 750 years (Petersen et al. 1996). The Rocky Ledge and Pittville faults appear to also be part of the Hat Creek fault system, as shown on the California Geological Survey Web site. Blakeslee and Katterhorn independently found a magnitude of 6.7 with a return interval of 667 ±167 years for the Hat Creek fault system. The U.S. Geological Survey (USGS) hazard assessment for the Hat Creek fault system ranges between a magnitude of 6.7 and 7.2 for the different faults in the fault system (http://geohazards.usgs.gov/cfusion/ hazfaults_search/disp_hf_info.cfm?cfault_id=8,%209). However, as addressed in Blakeslee and Katterhorn, there is no historic record (i.e., within the last 200 years) of movement, and they estimate the recurrence interval for the fault system to be in the range of 1,000 to 3,000 years. Therefore Blakeslee and Katterhorn assign a seismic hazard rating of "moderate," given the lack of historical earthquake events. LaForge and Hawkins (1986) identified the Hat Creek fault system as having a seismic risk rating of "potential." They associated the Holocene movement within the Modoc Geomorphic Province to be related to the extension of the high-angle block faulting in the Basin and Range Geomorphic Province located to the east on the California/Nevada border. Subsequent research, as noted by Blakeslee and Katterhorn (2013), has added credibility to this interpretation.

Northeast of the Shasta Lake and vicinity area, Quaternary-age faults (e.g., most recent movement was within the last 2 to 3 million years and therefore, the faults are potentially active under the Alquist-Priolo Act) include the Gillem-Big Crack faults near the California-Oregon border southeast of Lower Klamath Lake and the Cedar Mountain Fault southwest of Lower Klamath Lake. The faults in this zone are capable of earthquakes up to magnitude 7.0. Farther northeast, the Likely Fault is judged capable of a magnitude 6.9 earthquake. In the northeast corner of the state, the Surprise Fault is capable of a magnitude 7.0 earthquake. According to LaForge and Hawkins (1986), the nearest Quaternary-age fault is the Battle Creek fault located approximately 15 miles south-southeast of Redding. They estimate that the most recent movement on this fault occurred approximately 400,000 to 550,000 years ago. This fault has been rated by LaForge and Hawkins to not be a source of a major earthquake that may affect Shasta Dam.

Seismic activity has been reported in the area of Shasta Dam and Shasta Lake and has typically been in the 5.0 magnitude or lower range. The nearest seismic activity to Shasta Dam and Shasta Lake was a magnitude 5.2 earthquake that occurred 3 miles northwest of Redding, near Keswick Dam, in 1998 (Petersen 1999). LaForge and Hawkins (1986) found that the historical seismicity in the vicinity of the dam to be a “low level, with poorly located small magnitude events recorded.” They also found that no faults exist in and near the dam footprint and concluded that surface fault displacement in the dam foundation or reservoir is not considered to be a “credible event.”

Volcanic Eruptions and Associated Hazards Volcanic hazards include potential eruptions, and their products and associated hazards. In the Shasta Lake and vicinity area these include lava flows, pyroclastic flows, domes, tephra, and mudflows and floods triggered by eruptions. Three active centers of volcanic activity, all associated with the Modoc Plateau and Cascades Geomorphic Province, occur near enough to the Shasta Lake and vicinity area and merit discussion: the Medicine Lake Highlands, Lassen Peak, and Mount Shasta.

The Medicine Lake Highlands is located approximately 65 air miles northeast of Shasta Lake and includes a broad shield volcano that has a large caldera at its summit and more than 100 smaller lava cones and cinder cones on its flanks. The volcano developed over a period of 1 million years, mainly through lava flows. The most recent activity was approximately 500 years ago, when a large tephra eruption was followed by an extrusion of obsidian. Volcanic activity is likely to persist in the future (USFS 1994), specifically as local lava flows and tephra eruptions.

Lassen Peak lies 50 miles southeast of Shasta Lake. Lassen Peak is a cluster of dacitic domes and vents that have formed over the past 250,000 years. The most recent eruption occurred in 1914. That eruption began as a tephra eruption with steam blasts, and climaxed with a lateral blast, hot avalanches, and mudflows. Most ash from the 1914 eruption was carried to the east of the volcano.

The most prominent, active volcanic feature in the vicinity of Shasta Lake is Mount Shasta, which is located approximately 45 miles north of Shasta Lake. Mount Shasta has erupted at least once per 800 years during the last 10,000 years, and about once per 600 years during the last 4,500 years. Mount Shasta last erupted in 1786. Eruptions during the last 10,000 years produced lava flows and domes on and around the flanks of Mount Shasta. Pyroclastic flows extended up to 12 miles from the summit. Most of these eruptions also produced mudflows, many of which reached tens of miles from Mount Shasta.

Eruptions of Mount Shasta could endanger the communities of Weed, Mount Shasta, McCloud, and Dunsmuir. Such eruptions will most likely produce deposits of lithic ash, lava flows, domes, and pyroclastic flows that may affect low- and flat-lying ground almost anywhere within 12 miles of the summit. However, on the basis of its past behavior, Mount Shasta is not likely to erupt large volumes of pumiceous ash (tephra) in the future. Areas subject to the greatest risk from air-fall tephra are located mainly east and within about 30 miles of the summit (Miller 1980).

Floods commonly are produced by melting of snow and ice during eruptions of ice-clad volcanoes like Mount Shasta, or by heavy rains that may accompany eruptions. By incorporating river water as they move down valleys, mudflows may grade into slurry floods carrying unusually large amounts of rock debris. Eruption-caused floods can occur suddenly and can be of large volume. If floods caused by an eruption occur when rivers are already high, floods far larger than normal can result. Streams and valley floors around Mount Shasta could be affected by such floods as far downstream as Shasta Lake. The danger from floods caused by eruptions is similar to that from floods having other origins, but floods caused by eruptions may be more damaging because of a higher content of sediment that would increase the bulk specific gravity of the fluid (Miller 1980).

Mudflows Small mudflows not caused by eruptions are common at Mount Shasta. Relatively small but frequent mudflows have been produced historically (1924, 1926, 1931, and 1977) by melting of glaciers on Mount Shasta during warm summer months. Mudflows that occurred during the summer of 1924 entered the McCloud River and subsequently flowed into the Sacramento River (Miller 1980). In summer 2014, warm temperatures combined with accelerated glacial melt resulted in very turbid flows emanating from Mud Creek that affected the McCloud River (de la Fuente 2014).

Snow Avalanches Avalanche hazards near the Shasta Lake and vicinity area typically occur in steep, high-elevation terrane. These areas are generally above the tree line or in sparsely vegetated areas. Significant avalanche areas are limited to locations on the upper slopes outside of the Shasta Lake and vicinity area. It is noteworthy that a large snow avalanche occurred in the Sacramento River canyon near Dunsmuir, California, in the 1890s (Southern 1966).

Slope Instability (Mass Wasting) Slope instability hazards occur in areas of active and relict mass wasting features (e.g., active and relict landslides, debris flows, inner gorge landscape positions, and complexes of these features). Slope instability hazards occur throughout the Shasta Lake and vicinity area, and are most common in areas of steep topography. Locations in the Shasta Lake and vicinity area of mapped slope instability hazards are shown in Figure 4-4.

Reservoir Triggered Seismicity Shasta Lake and vicinity area could be subjected to reservoir triggered seismicity (RTS). The International Committee on Large Dams (ICOLD 2011), in their draft "Reservoirs and Seismicity – State of Knowledge" accept reservoir triggered seismicity as the most adequate term to describe the phenomena of earthquakes occurring in the vicinity of man-made water reservoirs. The two principal triggers of RTS are added weight stresses and pore pressure propagation. Lake Shasta experienced an RTS event during the initial filling. Based on the work by Packer et al. (1979) the seismic event occurred subsequent to reservoir impoundment. The largest magnitude was approximately 3.0 and occurred a few kilometers southeast of the reservoir (Packer et al. 1977).

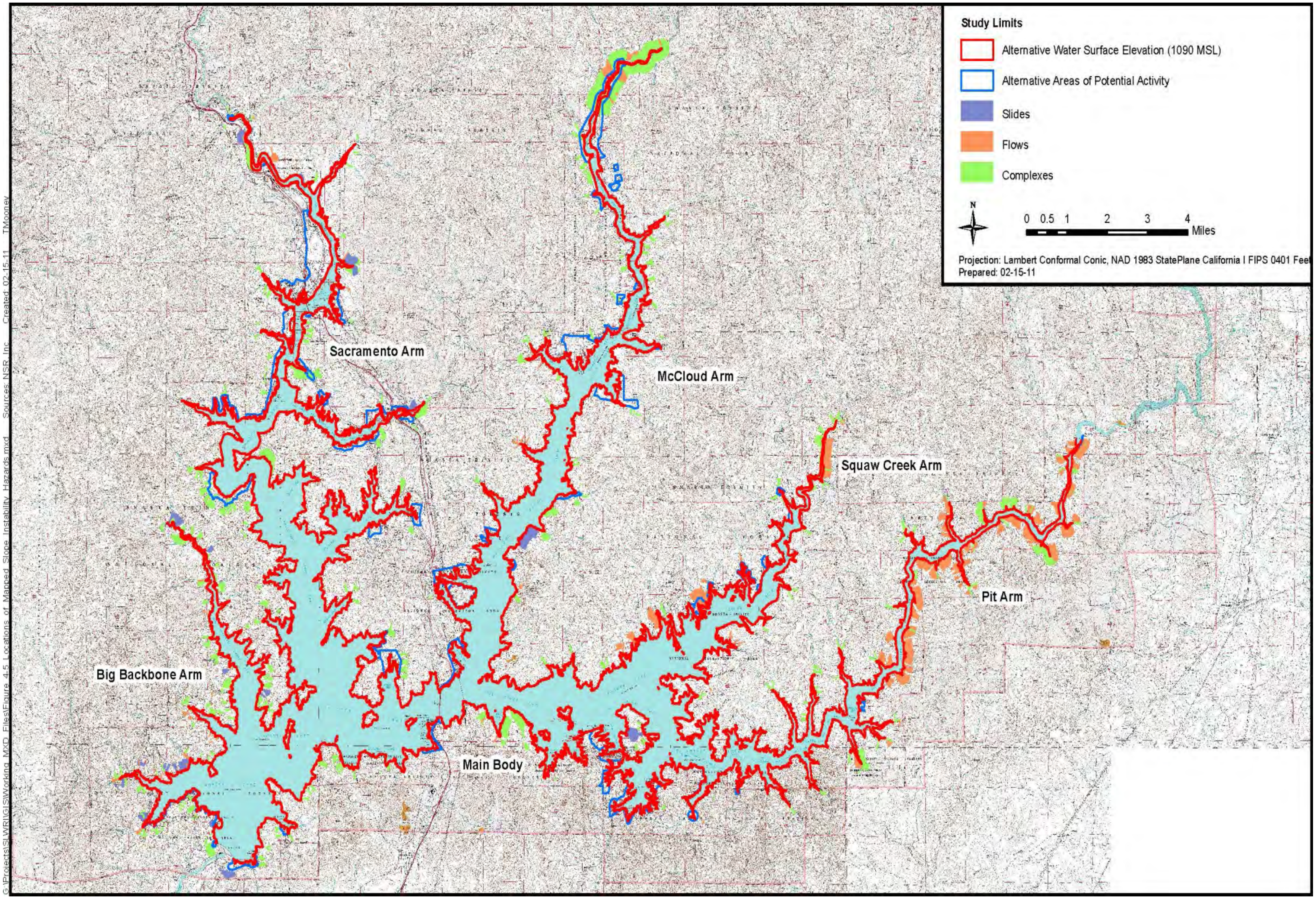


Figure 4-4. Locations of Mapped Slope Instability Hazards – Shasta Lake and Vicinity

The terrane underlying the Shasta Lake and vicinity area and the surrounding region has been influenced by a combination of tectonic uplift, mass wasting, and fluvial and surface erosion processes. The influence of these processes is ongoing, with evidence of ancient and more recent mass wasting features over the entire area, consisting of debris slides, torrents, and flows, with lesser amounts of rotational/translational landslides. The extent or distribution of mass wasting features across the region is believed not to have changed appreciably as a result of land use activities following Anglo-American settlement (USFS 1998).

Much of the topography in the general vicinity of Shasta Lake is steep, with concave swales; therefore, landslides are relatively common, ranging from small mudflows and slumps to large debris slides, debris flows, and inner gorge landslides. Small shallow debris slides associated with localized alluvial/colluvial rock units occur along the shoreline of Shasta Lake. Rockslides caused by mining activities have also occurred on the slopes surrounding Shasta Lake.

The areal extent of mapped slope instability hazards in the Shasta Lake and vicinity area is presented in Table 4-5 for the portion of the area between 1,070 feet and 1,090 feet above msl (Impoundment Area), and in Table 4-6 for the portion potentially disturbed by construction activities under the action alternatives (Relocation Areas). About 173 acres (7 percent) of the Impoundment Area is occupied by features that are potentially unstable. Potentially unstable features occupy about 232 acres (7 percent) of the Relocation Area. Most of the mapped slope instability hazards are debris flows.

Table 4-5. Areal Extent of Mapped Slope Instability Hazards – Shasta Lake and Vicinity (Impoundment Area)

Map Unit	Formation	Acres	% of Impoundment Area Acreage
1050	Slides	9.5375	0.38%
1100	Flows	66.6091	2.67%
1200	Complexes	97.1695	3.89%

Table 4-6. Areal Extent of Mapped Slope Instability Hazards – Shasta Lake and Vicinity (Relocation Areas)

Map Unit	Formation	Acres	% of Relocation Area Acreage
1050	Slides	2.9947	0.09%
1100	Flows	52.9767	1.59%
1200	Complexes	175.8020	5.26%

Seiches A seiche is an oscillation of a body of water in an enclosed or semienclosed basin that varies in period, depending on the physical dimensions of the basin, from a few minutes to several hours, and in height from a few millimeters to a few meters. Seiches arise chiefly as a result of sudden local changes in atmospheric pressure, aided by wind and occasionally tidal currents. Seiches can also be triggered by strong earthquake ground motion or large landslides entering a body of water.

If Mount Shasta were to erupt again, volcanic ash could fall in the study area, though as described previously, Mount Shasta is not likely to erupt large volumes of pumiceous ash (tephra) in the future. Minor seiches in Shasta Lake also could be generated by debris flows in the arms of the lake where its tributaries enter (City of Redding 2000). A large megathrust on the Cascadia subduction zone off the Pacific coast could generate enough ground shaking to generate a seiche in Shasta Lake. The Good Friday 1964 movement of the Cascadia subduction zone caused a seiche at Shasta Lake.

Regardless of its cause, the effects of a seiche would depend on the local conditions at the time. If the reservoir were filled to capacity, there may be some overspill by way of the dam spillways. Substantial overtopping of the dam itself is extremely unlikely, as such an event would require a seiche more than 6 meters high, even if the reservoir were filled to capacity. Excess flows into the Sacramento River triggered by a seiche in Shasta Lake would be attenuated by Keswick Reservoir (City of Redding 2000).

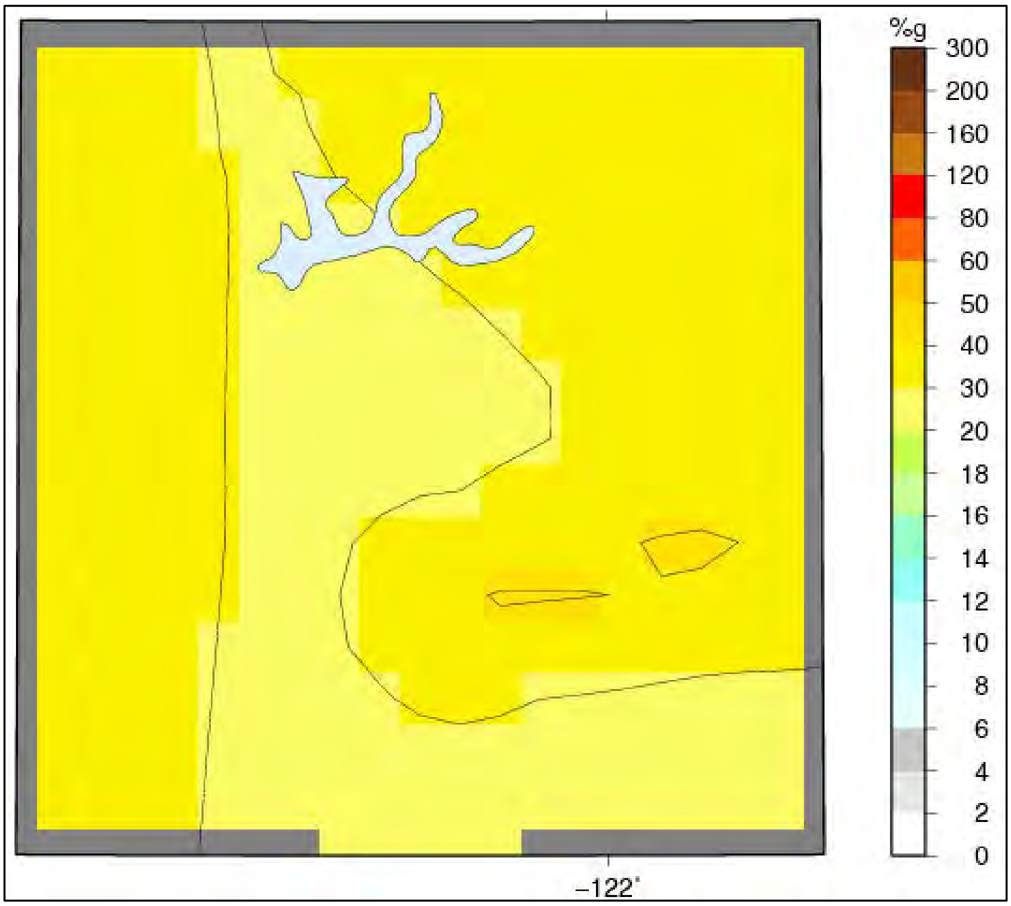
Upper Sacramento River (Shasta Dam to Red Bluff)

The upper Sacramento River portion of the primary study area could potentially be affected by geologic hazards in the region attributed to seismic hazards and volcanic eruptions and associated hazards. Mudflows, snow avalanches, slope instability, and seiches are not considered geologic hazards in this portion of the primary study area.

Seismic Hazards The northeastern area of Shasta County is part of an area between Lassen Peak and the Medicine Lake Highlands (in Siskiyou County), that is cut by a series of active normal faults that are part of the Sierra Nevada–Great Basin dextral shear zone (Shasta County 2004). These faults are likely to affect the upper watersheds northeast of the Sacramento Valley. These faults include the Mayfield–MacArthur–Hat Creek fault system (Blakeslee and Katterhorn 2013) approximately 50 miles east-northeast of Shasta Lake; the Gillem–Big Crack Faults, near the California-Oregon border southeast of Lower Klamath Lake; and the Cedar Mountain Fault, southwest of Lower Klamath Lake. The faults in this zone are capable of earthquakes up to magnitude 7.0. LaForge and Hawkins (1986) identified the Battle Creek fault approximately 15 miles south of Redding as the nearest Quaternary age fault but indicated that it is not a credible seismic hazard.

Shasta County is a seismically active region but has not experienced significant property damage or loss of life from earthquakes in the past 120 years. The City of Redding (2005) reported that maximum recorded intensities have reached Modified Mercalli VII. The majority of intense seismic activity in Shasta County has occurred in the eastern half of the county, around Lassen Peak (City of Redding 2005).

The *Shasta County General Plan* states that the maximum intensity event expected to occur in eastern Shasta County is Modified Mercalli VIII (Shasta County 2004). In the western half of Shasta County, the maximum intensity event is expected to be Modified Mercalli VII (City of Redding 2005). Shasta County is entirely within Seismic Zone 3 of the 2004 Uniform Building Code. Redding is an area of "moderate seismicity" and the Hat Creek and McArthur areas are of "moderate-to-high seismicity" (Shasta County 2004). A probabilistic seismic hazard map from the 2008 USGS conterminous data set is presented in Figure 4-5, which illustrates the peak ground acceleration (PGA) for 2 percent chance of exceedence in 50 years or a return period of 2,475 years (USGS 2014). This figure shows that in the vicinity of Shasta Lake the PGA varies from 0.3 – 0.4 g.



Source: USGS 2014

Figure 4-5. USGS 2008 Peak Ground Acceleration 2 Percent Chance of Exceedence in 50 Years in the Primary Study Area

South of Shasta County along the upper Sacramento River, potential slipping and seismic shaking could be associated with the Great Valley blind thrust fault system, which is capable of earthquakes up to magnitude 6.8 along the west side of the Sacramento Valley. This fault system is not considered active by the Alquist-Priolo Act, because blind thrust faults do not exhibit surface traces, but is identified in a database of potential earthquakes (Working Group of Northern California Earthquake Potential 1996). This fault system forms the boundary between the Coast Ranges and the Sacramento and San Joaquin valleys.

The San Andreas Fault system is located west of the Sacramento and San Joaquin valleys and is made up of a series of faults that lie along a 150-mile-long northwest-trending zone of seismicity. This zone is 10–45 miles west of the Sacramento Valley and extends from Suisun Bay past Lake Berryessa and Lake Pillsbury to near the latitude of Red Bluff. The Green Valley, Hunting Creek, Bartlett Springs, Round Valley, and Lake Mountain faults are the mapped active faults of the San Andreas Fault system most likely to affect the upper watersheds west of the Sacramento Valley. The faults in this system are capable of earthquakes up to 7.1 in magnitude.

The Indian Valley Fault, located southeast of Lake Almanor, and the Honey Lake Fault zone, located east of Lake Almanor, are likely to affect the upper watersheds east of the Sacramento Valley and are capable of a magnitude 6.9 earthquake. Surface rupture occurred in 1975 along the Cleveland Hill Fault south of Lake Oroville. The Foothills Fault system, which borders the east side of the Sacramento and San Joaquin valleys, is judged to be capable of a magnitude 6.5 earthquake.

Volcanic Eruptions and Associated Hazards Shasta County is at the southern end of the Cascade Range (as described above for the geology of the upper Sacramento River). The most recent volcanic activity in Shasta County occurred between 1914 and 1917, when Lassen Peak erupted, producing lava flows, numerous ash falls, and a large mudflow. The mudflow, a result of melting snow and ash, flowed down Lost Creek and Hat Creek (Shasta County 2004).

It is unlikely that a large mudflow from Mount Shasta would endanger Shasta County (Shasta County 2004).

Lower Sacramento River and Delta

The lower Sacramento River and Delta portion of the extended study area could potentially be affected by geologic hazards in the region attributed to seismic hazards. Volcanic eruptions and associated hazards, mudflows, snow avalanches, slope instability, and seiches are not considered geologic hazards in this portion of the extended study area.

The nearest fault to the lower Sacramento River below Red Bluff is the Dunnigan Hills Fault, which has experienced fault displacement in the Late

Quaternary and potential displacement in the Holocene along a separate segment of the fault (Jennings and Bryant 2010). The Dunnigan Hills Fault runs along the Sacramento River and is located between 6 and 10 miles west of the river near the town of Dunnigan. The Cleveland Fault is located approximately 30 miles east of the Sacramento River near the city of Oroville and is considered historic, having experienced displacement in the last 200 years (Jennings and Bryant 2010). In addition, the Great Valley blind thrust fault system (not considered active by the Alquist-Priolo Act) and San Andreas fault system extends along the Sacramento River to the west, as described above for the upper Sacramento River portion of the primary study area.

Failure of Delta levees is the primary threat to the region as a result of seismic activity. The Delta levees are located in a region of relatively low seismic activity compared to the San Francisco Bay Area (Bay Area). The major strike-slip faults in the Bay Area (the San Andreas, Hayward, and Calaveras faults) are located more than 16 miles from the Delta. The less active Green Valley and Marsh Creek–Clayton faults are more than 9 miles from the Delta. Small but significant local faults are situated in the Delta, and there is a possibility that blind thrust faults occur along the west Delta.

CVP/SWP Service Areas

The CVP/SWP service areas portion of the extended study area could potentially be affected by geologic hazards in the region attributed to seismic hazards. Volcanic eruptions and associated hazards, mudflows, snow avalanches, slope instability, and seiches are not considered geologic hazards in this portion of the extended study area. A number of active faults exist along the Sacramento and San Joaquin rivers in the CVP/SWP service areas.

Major earthquake activity has centered along the San Andreas Fault zone, including the great San Francisco earthquake of 1906 in the Bay Area. Since that earthquake, four events of magnitude 5.0 on the Richter scale or greater have occurred in the Bay Area. The San Andreas and Hayward faults remain active, with evidence of recent slippage along both faults.

In the San Joaquin River region, the Great Valley blind thrust fault system forms the boundary between the Coast Ranges and the west boundary of the San Joaquin Valley. This fault system is capable of earthquakes up to magnitude 6.7 along the west side of the San Joaquin Valley.

Active faults likely to affect the upper watersheds at the end of the San Joaquin Valley include the White Wolf Fault, which ruptured in 1952 with a magnitude 7.2 earthquake; the Garlock Fault, capable of a magnitude 7.3 earthquake; and several smaller faults 10–30 miles north of the White Wolf Fault.

A list of all of the reported faults, fault zones, and systems, according to the California Geological Survey, are presented in the Fault Activity Map of

California (Jennings and Bryant 2010) and the explanatory text to accompany the map.

4.1.3 Geomorphology

Geomorphology in the study area is described below for both the primary and extended study areas.

Shasta Lake and Vicinity

As described previously, most of the Shasta Lake and vicinity area is within the Klamath Mountains Geomorphic Province. The topography of the study area ranges from moderate to steep, and elevation ranges from approximately 1,070 feet to more than 6,000 feet above msl. The orientation and slopes of the ridges are controlled by the bedrock geology and structure. Generally speaking, the eastern slopes of the ridges are steeper than the western slopes. Hillslope gradient in the Shasta Lake and vicinity area ranges from 0 percent to more than 100 percent.

The regional stream network and boundaries of watersheds adjacent to Shasta Lake are shown in Figure 4-6. The boundaries of watersheds adjacent to Shasta Lake (shown in Figure 4-6) are the same as the boundaries of the area’s 6th Field Hydrologic Unit Code watersheds defined by USFS.

Regional-scale characteristics of the streams that are tributary to Shasta Lake are presented in Figure 4-7, where they are organized by arm. The total area of watersheds draining to the lake on a regional scale is 6,665 square miles. Of this total, watersheds that are immediately adjacent and contribute directly to Shasta Lake (i.e., 6th Field Hydrologic Unit Code watersheds) occupy about 512 square miles (Table 4-7). These immediately adjacent watersheds include small portions of the five major tributaries to Shasta Lake (Big Backbone Creek, the Sacramento and McCloud rivers, Squaw Creek, and the Pit River) and small watersheds that are adjacent and directly contributory to the Main Body of the lake.

In general, the stream networks adjacent and directly tributary to Shasta Lake are irregular and dendritic. The drainages are steep, and the drainage density ranges from 3.0 to 6.4 miles of stream per square mile of drainage area (Table 4-7). The drainage density is the lowest in the Main Body of the lake because this area has several small catchments. The density is the highest in the more well-defined arms, a function of the larger catchment areas of the tributary watersheds.

The lengths of streams within watersheds that are adjacent to Shasta Lake are also reported in Figure 4-7, where they again are aggregated by arm and further subdivided by flow regime (intermittent or perennial) and stream gradient. There are about 1,200 intermittent and perennial stream channels totaling about 2,903 miles that enter directly into Shasta Lake. These values do not include large parts of the Sacramento River, Squaw Creek, Pit River, McCloud River, and Big Backbone Creek watersheds, only the "face drainages" within the arms themselves.

Most of the stream channels that flow into Shasta Lake are intermittent and have stream slopes greater than 10 percent (mean gradient of 27 percent). Net Trace model results indicate that about 33 percent of these stream channels are perennial. About 20 percent of these channels (716) have gradients less than 10 percent and are likely to support fish and other aquatic organisms. In terms of the total number of channels, the Sacramento arm has the highest proportion (27 percent). There is approximately 707 miles of low gradient channel; 61 percent of this channel type contributes flow, sediment and organic material in the Pit (145 miles), Sacramento (150 miles) and Squaw Creek (134 miles) arms.

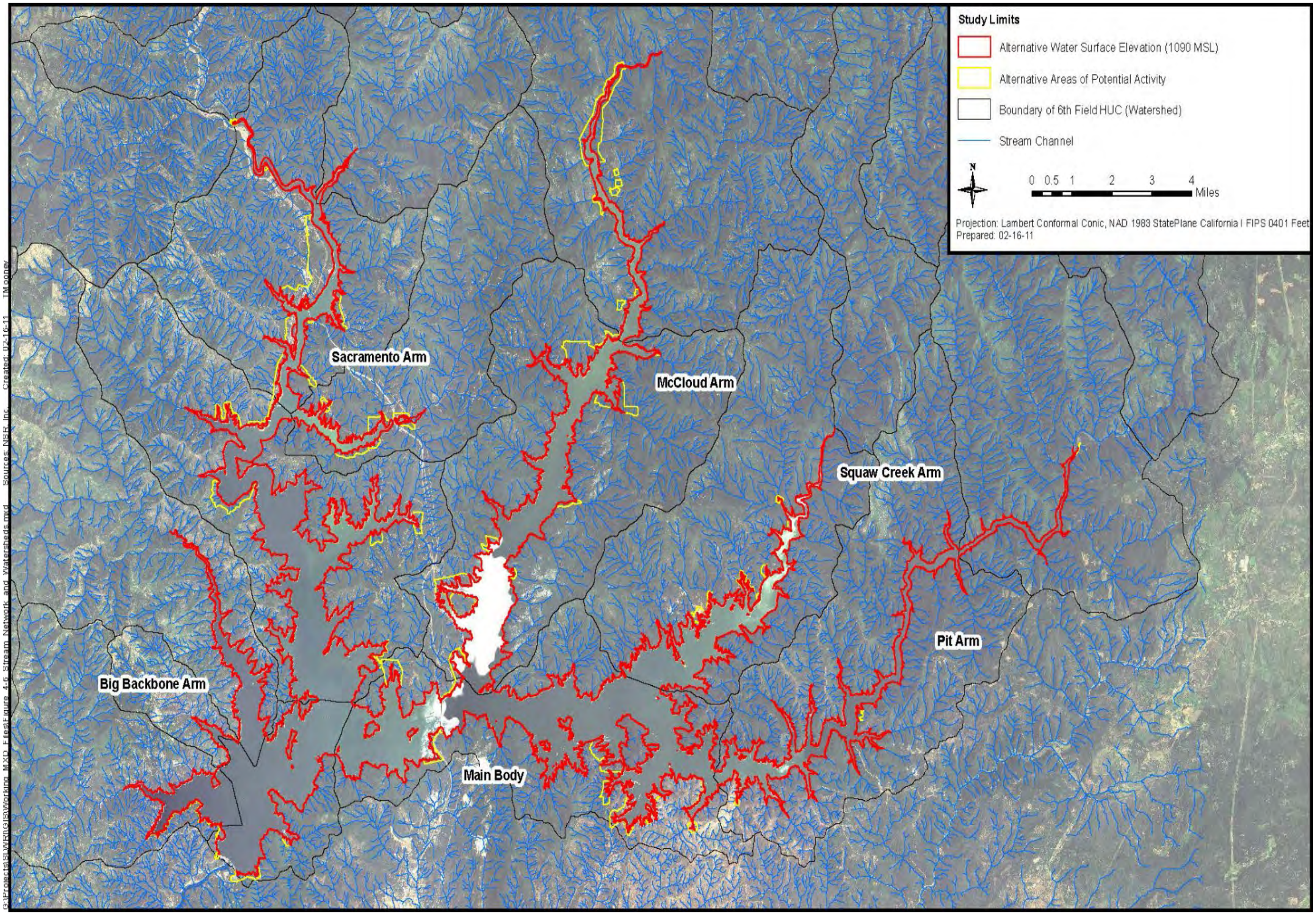
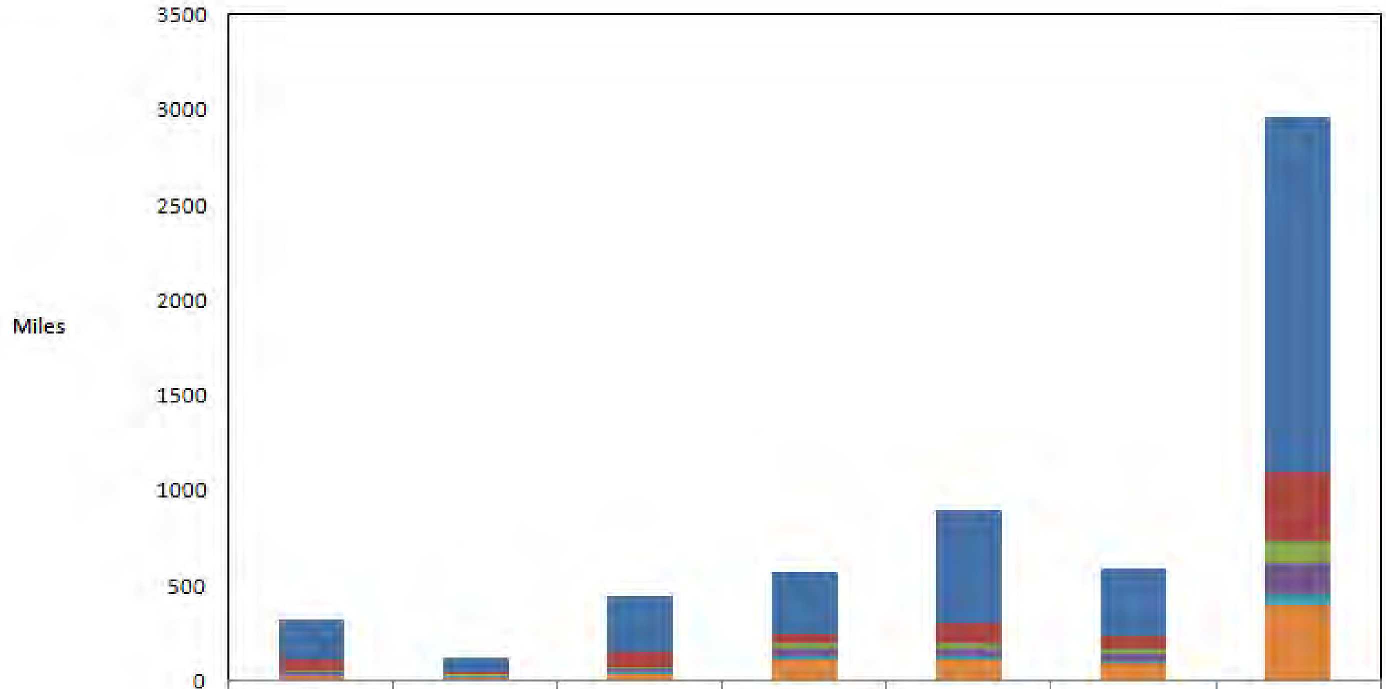


Figure 4-6. Regional Stream Network and Boundaries of Watersheds Adjacent to Shasta Lake and Vicinity



	Big Backbone Creek	Main Body	McCloud River	Pit River	Sacramento River	Squaw Creek	Total Length
Intermittent >10% Grade	214	83	297	321	597	355	1867
Perennial >10% Grade	60	6	75	51	101	71	364
Intermittent 7-10% Grade	4	10	9	31	30	24	108
Perennial 7-10% Grade	18	3	25	36	41	38	161
Intermittent <7% Grade	2	10	5	21	20	8	66
Perennial <7% Grade	30	14	38	109	109	96	396

Figure 4-7. Regional-Scale Characteristics of Streams Tributary to Shasta Lake

Table 4-7. Characteristics of Watersheds Adjacent and Directly Tributary to Shasta Lake

Lake Arm	Drainage Area (square miles)	Stream Length (miles)	Drainage Density (miles/square miles)	Average Elevation (feet)	Max Elevation (feet)	Mean Annual Precipitation (inches)
Big Backbone Creek	60	328	5.5	2,185	4,633	74
Main Body	37	126	3.4	1,260	2,723	67
McCloud River	77	449	5.8	1,911	4,669	79
Pit River	100	569	5.7	1,700	3,246	73
Sacramento River	137	898	6.5	1,825	4,589	76
Squaw Creek	100	592	5.9	2,100	5,046	83
Total	512	2,962	5.8	1,885	5,046	77

Using existing data and information (NSR 2003, Reclamation 2014), the following observations were made about the relative stability of the riverine reaches. Of the five main tributaries to Shasta Lake, all except Big Backbone Creek and the Sacramento River are underlain by shallow bedrock that limits channel incision. For this reason, Squaw Creek and the Pit and McCloud rivers have relatively stable channels that are unlikely to change significantly in response to average floods. Although they occur infrequently, debris flows have the potential to substantially affect particularly shallow bedrock reaches of smaller tributaries to Shasta Lake, as is evident in Dekkas Creek. The Sacramento River and Big Backbone Creek are relatively dynamic because the channel bed has the potential to undergo physical changes in response to a moderate floods. Although Big Backbone Creek and Squaw Creek have similar watershed areas, Squaw Creek has more bedrock reaches than Big Backbone Creek and therefore is inherently more stable.

A unique aspect of the channels that enter Shasta Lake is the fact that each one, whether large or small, is subject to periodic inundation and drawdown on an annual and often inter-annual basis. This process results in riverine aquatic habitat that is transitional in nature, with the bed and banks changing in response to reservoir operations. In 2014, Reclamation completed a study that characterized the habitat in a wide array of intermittent and perennial channels that flow into Shasta Lake (Reclamation 2014).This study documented that habitat types within these transitional reaches are dynamic; habitat values are variable and structural complexity is lacking in many of these channels.

Upper Sacramento River (Shasta Dam to Red Bluff)

The geomorphology of the Sacramento River is a product of several factors: the geology of the Sacramento Valley, hydrology, climate, vegetation, and human activity. Large flood events drive lateral channel migration and remove large flow impediments. Riparian vegetation stabilizes riverbanks and reduces water velocities, inducing deposition of eroded sediment. In the past, a balance existed between erosion and deposition along the Sacramento River. However, construction of dams, levees, and water projects has altered streamflow and other hydraulic characteristics of the Sacramento River. In some areas, human-induced changes have stabilized and contained the river, while in other reaches, the loss of riparian vegetation has reduced sediment deposition and led to increased erosion.

Human-induced changes have also affected geomorphology of downstream tributaries to the Sacramento River in the study area. Major tributaries include Clear, Cottonwood and Cow Creeks.

Cow Creek The 275,000-acre Cow Creek Watershed is a large, generally uncontrolled tributary to the Sacramento River on the eastern side. The watershed is unique in that land ownership is almost evenly divided between commercial forestland, commercial agriculture, and small rural property owners, with minimum government ownership (WSRCD and CCWMG 2005).

Copper, coal, gravel and quarry stone have been mined from the Cow Creek watershed in the past. In contrast to other tributaries, gold was not discovered on the eastside of the Sacramento River in this area. However, the available timber and grazing lands on the eastern lands became primary supply areas for the initial gold and copper mining that occurred in other parts of the region (WSRCD and CCWMG 2001).

Gravel was mined in Little Cow Creek near Bella Vista (at Dry Creek and at Salt Creek), near Palo Cedro (Graystone Court and near Bloomingdale Road), and in the lower reaches of the main stem of Cow Creek. Mining of gravel in active floodways has likely reduced available spawning gravel in Little Cow Creek and the main stem of Cow Creek. Gravel removal may also have contributed to channel incisement (WSRCD and CCWMG 2005).

Ranching is currently a dominant land use in the watershed. Diversions of water for ranching activities significantly affect instream flow on the lower reaches of Cow Creek during the summer season (WSRCD and CCWMG 2005).

Major issues in the Cow Creek watershed are water quality and quantity for agriculture uses and natural barriers to fish passage (waterfalls) located at geologic contacts which limit anadromous fish passage into four of the five tributaries to Cow Creek. Geomorphic changes in Cow Creek (i.e., knickpoints) are attributed to natural breaks in the geology of the area and not to human activities. A review of historic aerial photos and available maps show that the configuration of the channel on the main stem has not changed significantly over the last century (WSRCD and CCWMG 2005).

Cottonwood Creek Cottonwood Creek is the largest undammed watershed on the west side of the Sacramento Valley. The watershed is characterized by a flashy hydrology due to the absence of any flow regulating dams, and low intra-annual storage resulting from a combination of very little recharge to aquifers in the upper reaches of the watershed and a small amount of snow pack (CH2M HILL 2005, 2007).

Human impacts on Cottonwood Creek began in the 1850s with placer and dredge gold mining operations. Two major gravel mines currently operate on Cottonwood Creek. The Shea Mine, which is in Shasta County, is immediately downstream from Interstate 5, and the Cottonwood Creek Sand and Gravel Mine (formerly XTRA), which is in Tehama County, is approximately 0.5 mile upstream from Interstate 5 (CH2M HILL 2001).

Several reports suggest that persistent gravel mining combined with a flashy hydrology contribute to instability in channel conditions, excessive bank erosion, and bed degradation in Cottonwood Creek (DWR 1992, Matthews 2003). Cross-sectional survey locations established by the USGS in 1983 and re-surveyed in 2002 show that considerable channel incision has occurred on Cottonwood Creek; in some areas, the channel is scoured to bedrock. These changes are likely caused by instream aggregate mining in excess of annual replenishment rates (Matthews 2003).

Clear Creek To characterize existing fluvial geomorphic conditions, Clear Creek is divided into upper Clear Creek and lower Clear Creek, with the delineation occurring at Whiskeytown Dam. Upper Clear Creek (upstream from Whiskeytown Dam) is not discussed further in this section.

The lower Clear Creek watershed has been impacted by direct and indirect human activities for over a century. Widespread alterations to the watershed began in the 1800s, when the channel was placer mined and then dredged for gold, which caused extensive modifications to natural channel form and process by removing point bars, floodplains, and riparian vegetation (WSRCD 1996). In some areas, the stream is incised completely down to clay hardpan or bedrock. Clear Creek is straight and highly entrenched in some areas; in others, it has multiple, braided channels due to direct and indirect human impacts (GMA 2007). Later, timber harvesting and associated road building caused excessive erosion throughout the watershed (WSRCD 1996).

The construction of McCormick-Saeltzer Dam in 1903 (dam removed in 2000) caused further changes in streamflow and sediment transport in the stream. Alteration of the natural flow and sediment regime in Clear Creek continued with construction of Whiskeytown Dam in 1963. Whiskeytown Dam greatly reduced the volume and magnitude of historical flows and effectively blocks the downstream transport of coarse sediment to lower Clear Creek (WSRCD 1996).

More recently, instream and off-channel aggregate mining began in 1950 and continued through the mid-1980s. Several hundred thousand cubic yards of aggregate were removed from Clear Creek below the former site of McCormick-Saeltzer Dam, destroying the bankfull channel and in some areas completely removing the floodplain (WSRCD 1996).

Lower Clear Creek is the subject of several ongoing geomorphic studies, monitoring efforts, and fish habitat and channel restoration activities intended to offset past impacts on the watershed and stream channel by introducing spawning gravels into lower Clear Creek, implementing erosion control programs, and reducing fuels within the watershed (Reclamation 2012). The Lower Clear Creek Floodway Rehabilitation Project is an extensive effort to restore the natural form and function of the Clear Creek channel and floodplain in areas highly affected by gold and aggregate mining.

Two headcuts have been observed on lower Clear Creek. The upstream-most headcut was observed in 2003, upstream from the former McCormick-Saeltzer Dam location. This headcut is the result of natural channel adjustment following dam removal in 2000 combined with a large storm event that occurred in December 2002 (UC Berkeley 2003). The headcut near the former dam site was observed again during monitoring activities in 2006 (GMA 2007). As of 2011, the channel appears to have stabilized in the vicinity of the former dam, with normal patterns of aggradation and deposition occurring within the reach (UC Berkeley 2011).

A second headcut has been observed farther downstream in Clear Creek, near the location of the Lower Clear Creek Floodway Rehabilitation Project. This headcut is migrating from the upstream end of the restoration site and has been attributed to past gravel mining and reduction of coarse sediment by upstream dams. In some areas above and below the site, the channel has incised to clay hardpan. Continued gravel augmentation upstream from the restoration area may reduce the rate of channel downcutting in the future (GMA 2007).

Lower Sacramento River and Delta

Downstream from Red Bluff, the lower Sacramento River is relatively active and sinuous, meandering across alluvial deposits within a wide meander belt. The active channel consists of point bars composed of sand on the inside of meander bends, and is flanked by active floodplain and older terraces. Most of these features consist of easily eroded, unconsolidated alluvium; however, there are also outcrops of resistant, cemented alluvial units such as the Modesto and Riverbank formations. Geologic outcroppings and human-made structures, such as bridges and levees, act as local hydraulic controls and confine movement of much of the lower Sacramento River. Natural geomorphic processes in the Delta have been highly modified by changes to upstream hydrology (reservoirs and streamflow regulation) and construction of levees, channels, and other physical features.

Since construction of Shasta Dam in the early 1940s, flood volumes on the river have been reduced, which has reduced the energy available for sediment transport. Straightening and a reduced rate of meander migration of the river may be associated with flow regulation because of Shasta Dam. The reduction in active channel dynamics is compounded by the physical effects of riprap bank protection structures, which typically eliminate shaded bank habitat and associated deep pools, and halt the natural processes of channel migration.

CVP/SWP Service Areas

Geomorphology in the CVP/SWP service areas is a product of the same factors mentioned above – geology, hydrology and climate, vegetation, and human activity. Geomorphology in the CVP service areas is summarized in the descriptions of the primary study area and the lower Sacramento River and Delta portions of the extended study area.

Geomorphology in the SWP service areas extends into the southern geomorphic provinces of California and along part of the coast. The southern geomorphic provinces and coastal province include the Transverse Ranges, Peninsular Ranges, Mojave Desert, and Coast Ranges. The Transverse Ranges, composed of overlapping mountain blocks, consist of parallel and subparallel ranges and valleys. The Peninsular Ranges Geomorphic Province is composed of northwest- to southeast-trending fault blocks, extending from the Transverse Ranges into Mexico. The Peninsular Ranges are similar to the Sierra Nevada in that they have a gentle westerly slope and generally consist of steep eastern faces. The Mojave Desert Geomorphic Province's topography is controlled by two faults: the San Andreas Fault, trending northwest to southeast, and the Garlock Fault, trending east to west (Jennings 1938). Before development of the Garlock Fault, sometime during the Miocene, the Mojave Desert was part of the Basin and Range Geomorphic Province. The Mojave Desert is now dominated by alluvial basins, which are aggrading surfaces from adjacent upland continental deposits (Norris and Webb 1990). The Coast Ranges have been greatly affected by plate tectonics. The Coast Ranges Geomorphic Province consists of elongate ranges and narrow valleys that run subparallel to the coast. Some of the mountain ranges along the Coast Ranges terminate abruptly at the sea (Norris and Webb 1990).

4.1.4 Mineral Resources

This section describes the known mineral resources of commercial or otherwise documented economic value in both the primary and extended study areas. The mineral resources of concern include metals and industrial minerals (e.g., aggregate, sand, and gravel, oil and gas, and geothermal resources that would be of value to the region).

Shasta Lake and Vicinity

The following section describes mineral resources in the Shasta Lake and vicinity portion of the primary study area.

Metals The lands in the Shasta Lake and vicinity area are highly mineralized, with a history of significant mineral production. The Shasta Lake and vicinity area encompasses portions of two historic base metal mining districts, the west Shasta and east Shasta copper-zinc districts. The two districts focused on development of massive sulfide (Kuroko-type) deposits of submarine volcanogenic origin that formed contemporaneously with, and by the same process as, the host volcanic rocks. As in other areas in the Klamath Mountains, copper was by far the predominant commodity produced. Zinc, sulfur, iron, limestone, gold, and silver were produced as byproducts of copper production.

The Golinsky mine complex is located in the west Shasta district, approximately 7 miles west of Shasta Dam in the headwaters of Dry Creek and Little Backbone Creek. This inactive, abandoned mine complex is the only large historic producing mine within the Shasta Unit of the Whiskeytown-Shasta-Trinity NRA. Other mines within the NRA occur in the east Shasta district, concentrated between the McCloud and Squaw arms of Shasta Lake. The east Shasta district includes the Bully Hill, Copper City, and Rising Star mines, all of which are located in the Bully Hill area. These mines ceased operation before Shasta Dam was built.

These types of mineral deposits, in conjunction with the historic lode mining methods, have resulted in the discharge of toxic mine waste and acidic waters to Shasta Lake and some tributaries on a recurring basis (USFS 2000). The Golinsky mine complex has been subject to extensive remediation to reduce the discharge of toxic mine waste and acidic waters to Shasta Lake.

Industrial Minerals Industrial minerals occurring in the vicinity of Shasta Lake include alluvial sand and gravel, crushed stone, volcanic cinders, limestone, and diatomite. In 2002, Shasta County produced 462,000 tons of sand and gravel, 852,000 tons of crushed stone (including limestone), and 51,000 tons of volcanic cinders. Limestone (used to produce Portland cement) and diatomite are not included in these figures.

The supply of Portland cement concrete-grade alluvial sand and gravel within the region is more limited than the supply of non-Portland cement concrete-grade material. The primary sources for alluvial sand and gravel near the Shasta Lake and vicinity area are the Sacramento River (downstream from Keswick Dam), Clear Creek, Cottonwood Creek, and Hat Creek. Crushed stone has been produced at a limestone quarry in Mountain Gate, a granite quarry in Keswick, an andesite quarry in Mountain Gate, a shale quarry in Oak Run, and two basalt quarries in the Lake Britton area near Burney. Volcanic cinders are produced at sites east of the Shasta Lake and vicinity area.

Areas inundated by the reservoir have aggregate source areas available through dredging and/or excavation. Reclamation has ongoing efforts to characterize the quality and quantity of aggregate that may be used for various project-related needs.

Limestone is used in a variety of industrial applications, but the bulk of limestone is used for the production of Portland cement concrete. Most of the limestone resources found in and near the Shasta Lake and vicinity area are located in fairly remote mountainous areas where extraction is uneconomical.

However, significant mining of limestone for Portland cement concrete production occurs immediately south of Shasta Lake, in Mountain Gate. Diatomite is produced from sources near Lake Britton, east of the Shasta Lake and vicinity area.

Geothermal Resources Significant geothermal resources occur in the Medicine Lake Highlands, approximately 65 air miles northeast of Shasta Lake. The potential capacity of the Medicine Lake Highlands has been estimated at 480 megawatts (PacifiCorp 2010). Development of the Medicine Lake Highlands' geothermal resources has been the subject of extensive litigation of environmental issues and Native American concerns.

Upper Sacramento River (Shasta Dam to Red Bluff)

Economically viable minerals found within the upper Sacramento River portion of the primary study area consist of alluvial sand and gravel, crushed stone, volcanic cinders, limestone, and diatomite. Additional mineral resources are found in the surrounding regions in Shasta and Tehama counties. These mineral resources include asbestos, barium, calcium, chromium, copper, gold, iron, lead, manganese, molybdenum, silver, and zinc (USGS 2005).

Lower Sacramento River and Delta

Economically viable minerals found within the lower Sacramento River and Delta portion of the extended study area consist of alluvial sand and gravel, crushed stone, calcium, and clay. Additional mineral resources are found in the surrounding regions, including chromium, gold, granite, lithium, manganese, mercury, pumice, and silver (USGS 2005).

CVP/SWP Service Areas

The U.S. Geological Survey's mineral resources database indicates that numerous mineral resources found within the CVP/SWP service areas are or have been mined. These minerals include antimony, asbestos, barium, bismuth, boron, calcium, chromium, clay, copper, diatomite, feldspar, fluorite, gold, gypsum-anhydrite, halite, iron, lead, limestone, magnetite, manganese, marble, mercury, molybdenum, pumice, quartz, sand and gravel, silica, silver, slate, stone (crushed/broken), talc, tin, titanium, tungsten, uranium, and vanadium (USGS 2005).

4.1.5 Soils

Soils and erosion areas are described below for both the primary and extended study areas. Soils in the study area are described in the following sections in terms of their biomass productivity; susceptibility to erosion, subsidence, liquefaction, and expansion; and suitability for on-site application of waste material.

Soil biomass productivity is a measure of the capability of a site to produce biomass. The purpose of this management interpretation is to measure the site's productive capability when vegetative indicators (e.g., crop yields, site trees, and other vegetative biomass data) are not directly available. Factors that influence soil biomass productivity include soil depth, parent material, available water-holding capacity, precipitation, soil temperature regime, aspect, and reaction (i.e., pH). Soil biomass productivity is characterized using four relative rankings: high, moderate, low, and nonproductive.

The susceptibility of soil to erosion is characterized in terms of the soil's erosion hazard rating. The ratings indicate the hazards of topsoil loss in an unvegetated condition, as might occur following disturbance by construction. Ratings are based on the soil erosion factor (K), slope, and content of rock fragments. (The soil erosion factor (K) is a measure of the susceptibility of soil particles to detachment and transport by rainfall and runoff, based primarily on soil texture but also considering structure, organic matter, and permeability.) Three ratings are recognized: slight, moderate, and severe. A rating of "slight" indicates that no postdisturbance acceleration of naturally occurring erosion is likely; "moderate" indicates that some acceleration of erosion is likely, and that simple erosion-control measures are needed; and "severe" indicates that significant erosion is expected, and that extensive erosion-control measures are needed.

Land subsidence is broadly defined to mean the sudden sinking or gradual downward settling of the land surface with little or no horizontal motion. Land subsidence can arise from a number of causes: the weathering characteristics of the underlying bedrock (e.g., as occurs for certain limestone formations); decomposition of the organic matter fraction of soils that are derived from peaty or mucky parent materials; aquifer-system compaction; underground mining; and natural compaction. Three processes account for most instances of water-related subsidence: compaction of aquifer systems, drainage and subsequent oxidation of organic soils, and dissolution and collapse of susceptible rocks.

Soil liquefaction is a phenomenon in which the strength and stiffness of a soil is reduced by earthquake shaking or other rapid loading. Liquefaction occurs in saturated soils when the pore spaces between individual soil particles are completely filled with water. This water exerts a pressure on the soil particles that influences how tightly the particles themselves are pressed together. Before an earthquake, the water pressure is relatively low. However, earthquake shaking can cause the water pressure to increase to the point where the soil particles can readily move with respect to each other. When liquefaction occurs, the strength of soils decreases, and the ability of soils to support foundations for buildings and bridges is reduced.

Expansive soils are soils that contain water-absorbing minerals, mainly "active" clays (e.g., montmorillonite). Such soils may expand by 10 percent or more when wetted. The cycle of shrinking and expanding exerts continual pressure on structures, and over time can reduce structural integrity. Soil susceptibility to expansion (i.e., shrinking and swelling) is tested using Uniform Building Code Test Standard 18-1.

Soil suitability for on-site application of waste material focuses on the suitability of the soil to support the use of septic tanks or alternative wastewater disposal systems. Suitability interpretations are based on consideration of soil depth, permeability, rock content, depth to groundwater (including seasonally perched water), and slope.

Shasta Lake and Vicinity

Soils in the Shasta Lake and vicinity area derive from materials weathered from metavolcanic (e.g., basalt and greenstone) and metaigneous (e.g., granitic and serpentinite) rocks. Soils derived from the metavolcanic sources, such as greenstone, include the Goulding and Neuns families. Soils derived from metasedimentary materials include the Marpa family. Holland family soils are derived from metasedimentary and granitic rocks.

In general, metamorphosed rocks do not weather rapidly, and shallow soils are common in the area, especially on steep landscape positions. Soils from metamorphosed rocks generally contain large percentages of coarse fragments (e.g., gravels, cobbles, stones), which reduce their available water holding capacity and topsoil productivity. Granitic rocks may weather deeply, but soils derived from them may be droughty (unable to store water) because of high amounts of coarse quartz grains and low content of “active” clay. Soils derived from granitic rocks commonly are highly susceptible to erosion.

Soil map units in the Shasta Lake and vicinity area are shown in Figure 4-8; Table 4-8 presents the mapping legend that accompanies the figure. The areal extent of soil map units within the Shasta Lake and vicinity area is presented in Table 4-9 for the portion of the area between 1,070 feet and 1,090 feet above msl (Impoundment Area), and in Table 4-10 for the portion potentially disturbed by construction activities (Relocation Areas). Sixty soil map units, comprising soil families and miscellaneous land types (e.g., rock outcrop, limestone), are recognized to occur in the area. Common soil families are Marpa, Neuns, Goulding, and Holland. These are well-drained soils with fine loamy or loamy-skeletal (i.e., gravelly or cobbly) profiles.

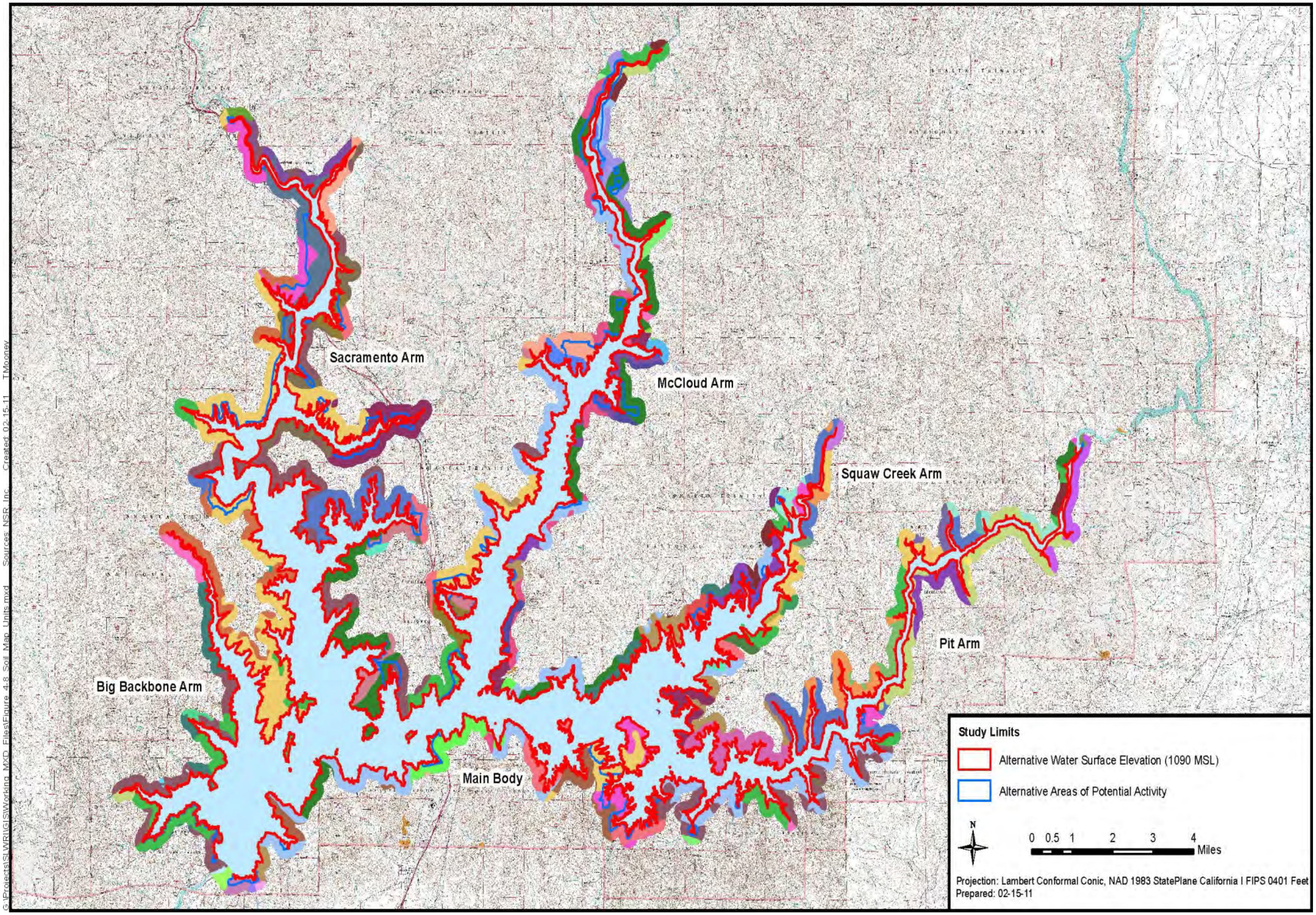


Figure 4-8. Soil Map Units – Shasta Lake and Vicinity

Table 4-8. Key to Soil Map Units – Shasta Lake and Vicinity

Map Unit, Map Unit Name
101, Holland-Goulding families association, 20 to 40 percent slopes.
102, Holland-Goulding families association, 40 to 60 percent slopes.
103, Holland-Goulding families association, 60 to 80 percent slopes.
104, Holland family-Holland family, deep complex, 20 to 40 percent slopes.
105, Holland family-Holland family, deep complex, 40 to 60 percent slopes.
107, Holland-Neuns families complex, 40 to 60 percent slopes.
109, Holland family, ashy, 0 to 20 percent slopes.
111, Holland, ashy-Leadmount families association, 0 to 20 percent slopes.
114, Holland, ashy-Washougal families complex, 25 to 65 percent slopes.
115, Holland family, deep, 0 to 20 percent slopes.
116, Holland family, deep, 20 to 40 percent slopes.
117, Holland family, deep, 40 to 60 percent slopes.
119, Holland family, deep-Holland families complex, 20 to 40 percent slopes.
120, Holland family, deep-Holland family complex, 40 to 60 percent slopes.
123, Holland, deep-Marpa families complex, 20 to 40 percent slopes.
127, Holland, deep-neuns families complex, 40 to 60 percent slopes.
133, Hugo family, 60 to 80 percent slopes.
139, Hugo-Neuns families complex, 60 to 80 percent slopes.
174, Marpa family, 20 to 40 percent slopes.
175, Marpa family, 40 to 60 percent slopes.
176, Marpa family, 60 to 80 percent slopes.
177, Marpa-Chawanakee families complex, 40 to 60 percent slopes.
178, Marpa-Goulding families association, 20 to 40 percent slopes.
179, Marpa-Goulding families association, 40 to 60 percent slopes.
18, Chaix family, 40 to 60 percent slopes.
180, Marpa-Goulding families association, 60 to 80 percent slopes.
182, Marpa-Holland, deep families complex, 20 to 40 percent slopes.
183, Marpa-holland, deep families complex, 40 to 60 percent slopes.
187, Marpa-Neuns families complex, 40 to 60 percent slopes.
188, Marpa-Neuns families complex, 60 to 80 percent slopes.
195, Millsholm family, 20 to 60 percent slopes.
203, Neuns family, 40 to 60 percent slopes.
204, Neuns family, 60 to 80 percent slopes.
209, Neuns-Goulding families association, 60 to 80 percent slopes.
214, Neuns-Holland, deep families complex, 40 to 80 percent slopes.
218, Neuns-Marpa families complex, 40 to 60 percent slopes.
219, Neuns-Marpa families complex, 60 to 80 percent slopes.
224, Neuns family-Typic Xerorthents association, 50 to 80 percent slopes.
228, Neuns family, deep-Neuns family complex, 40 to 70 percent slopes.
24, Chawanakee-Chaix families complex, 40 to 60 percent slopes.
250, Rock outcrop, limestone.

Table 4-8. Key to Soil Map Units – Shasta Lake and Vicinity (contd.)

Map Unit, Map Unit Name

- 251, Rock outcrop, metamorphic.
- 252, Rock outcrop, sedimentary.
- 259, Rock outcrop-Goulding family complex, 40 to 80 percent slopes.
- 27, Chawanakee family-Rock outcrop complex, 60 to 80 percent slopes.
- 35, Deadwood-Neuns families complex, 40 to 60 percent slopes.
- 61, Etsel family, 40 to 80 percent slopes.
- 79, Goulding family, 20 to 40 percent slopes.
- 80, Goulding family, 40 to 60 percent slopes.
- 81, Goulding family, 60 to 80 percent slopes
- 82, Goulding-Holland families association, 40 to 60 percent slopes.
- 83, Goulding-Marpa families association, 40 to 60 percent slopes.
- 85, Goulding family-Rock outcrop complex, 50 to 80 percent slopes
- 98, Holland family, 40 to 60 percent slopes.
- 99, Holland family, 60 to 80 percent slopes
- AtE2sh, Auburn very stony clay loam, 30 to 50 percent slopes, eroded
- AuF2sh, Auburn very rocky clay loam, 50 to 70 percent slopes, eroded
- BoF3sh, Boomer very stony clay loam, 50 to 70 percent slopes, severely eroded
- GeF2sh, Goulding very rocky loam, 50 to 70 percent slopes, eroded
- W, Water

Table 4-9. Areal Extent of Soil Map Units – Shasta Lake and Vicinity (Impoundment Area)

Map Unit	Map Unit Name	Acres	% of Total Subarea
18	Chaix family, 40–60% slopes	43.6	1.75%
27	Chawanakee family – Rock outcrop complex, 60–80% slopes	0.8	0.03%
35	Deadwood-Neuns families complex, 40–60% slopes	2.5	0.10%
61	Etsel family, 40–80% slopes	39.4	1.58%
79	Goulding family, 20–40% slopes	32.0	1.28%
80	Goulding family, 40–60% slopes	153.1	6.13%
81	Goulding family, 60–80% slopes	7.3	0.29%
82	Goulding-Holland families association, 40–60% slopes	45.3	1.81%
83	Goulding-Marpa families association, 40–60% slopes	118.5	4.74%
85	Goulding family – Rock outcrop complex, 50–80% slopes	10.8	0.43%
98	Holland family, 40–60% slopes	3.6	0.14%
99	Holland family, 60–80% slopes	8.4	0.34%
101	Holland-Goulding families association, 20–40% slopes	66.5	2.66%

Table 4-9. Areal Extent of Soil Map Units – Shasta Lake and Vicinity (Impoundment Area) (contd.)

Map Unit	Map Unit Name	Acres	% of Total Subarea
102	Holland-Goulding families association, 40–60% slopes	145.0	5.80%
103	Holland-Goulding families association, 60–80% slopes	4.6	0.18%
104	Holland family – Holland family, deep complex, 20–40% slopes	60.6	2.43%
105	Holland family – Holland family, deep complex, 40–60% slopes	215.3	8.62%
109	Holland family, ashy, 0–22% slopes	0.1	0.00%
111	Holland, ashy – Leadmount families association, 0–20% slopes	93.4	3.74%
114	Holland, ashy – Washougal families complex, 25–65% slopes	6.2	0.25%
115	Holland family, deep, 0–20% slopes	38.6	1.54%
116	Holland family, deep, 20–40% slopes	8.5	0.34%
117	Holland family, deep, 40–60% slopes	32.1	1.29%
119	Holland family, deep – Holland families complex 20–40% slopes	111.5	4.46%
120	Holland family, deep – Holland family complex, 40–60% slopes	70.4	2.82%
123	Holland, deep – Marpa families complex, 20–40% slopes	66.7	2.67%
127	Holland, deep – Neuns families complex, 40–60% slopes	4.1	0.16%
133	Hugo family, 60–80% slopes	5.2	0.21%
139	Hugo-Neuns families complex, 60–80% slopes	4.3	0.17%
174	Marpa family, 20–40% slopes	28.2	1.13%
175	Marpa family, 40–60% slopes	28.4	1.14%
177	Marpa-Chawanakee families complex, 40–60% slopes	47.1	1.89%
178	Marpa-Goulding families association, 20–40% slopes	74.7	2.99%
179	Marpa-Goulding families association, 40–60% slopes	309.8	12.40%
180	Marpa-Goulding families association, 60–80% slopes	10.2	0.41%
182	Marpa-Holland, deep families complex, 20–40% slopes	89.1	3.57%
183	Marpa-Holland, deep families complex, 40–60% slopes	162.4	6.50%
187	Marpa-Neuns families complex, 40–60% slopes	5.6	0.22%
188	Marpa-Neuns families complex, 60–80% slopes	0.2	0.01%
195	Millsholm family, 20–60% slopes	39.7	1.59%
203	Neuns family, 40–60% slopes	7.6	0.30%
204	Neuns family, 60–80% slopes	43.5	1.74%
209	Neuns-Goulding families association, 60–80% slopes	1.7	0.07%
214	Neuns-Holland, deep families complex, 40–80% slopes	8.5	0.34%
218	Neuns-Marpa families complex, 40–60% slopes	1.1	0.04%
219	Neuns-Marpa families complex, 60–80% slopes	23.9	0.96%
250	Rock outcrop, limestone	9.3	0.37%
251	Rock outcrop, metamorphic	0.0	0.00%
259	Rock outcrop – Goulding family complex, 40–80% slopes	0.5	0.02%
AtE2sh	Auburn very stony clay loam, 30–50% slopes, eroded	0.1	0.01%
BoF3sh	Boomer very stony clay loam, 50–70% slopes, severely eroded	7.4	0.30%
W	Water	200.7	8.03%

Table 4-10. Areal Extent of Soil Map Units – Shasta Lake and Vicinity (Relocation Areas)

Map Unit	Map Unit Name	Acres	% of Total Subarea
18	Chaix family, 40–60% slopes	48.6	1.46%
35	Deadwood-Neuns families complex, 40–60% slopes	1.5	0.04%
61	Etsel family, 40–80% slopes	42.2	1.26%
79	Goulding family, 20–40% slopes	50.4	1.51%
80	Goulding family, 40–60% slopes	179.3	5.37%
82	Goulding-Holland families association, 40–60% slopes	13.9	0.42%
83	Goulding-Marpa families association, 40–60% slopes	6.6	0.20%
85	Goulding family – Rock outrcrop complex, 50–80% slopes	14.6	44.00%
102	Holland-Goulding families association, 40–60% slopes	280.0	8.38%
103	Holland-Goulding families association, 60–80% slopes	2.0	0.06%
104	Holland family – Holland family, deep complex, 20–40% slopes	79.1	2.37%
105	Holland family – Holland family, deep complex, 40–60% slopes	170.9	5.12%
109	Holland family, ashy, 0–22% slopes	1.1	0.03%
111	Holland, ashy – Leadmount families association, 0–20% slopes	533.6	15.98%
114	Holland, ashy – Washougal families complex, 25–65% slopes	1.5	0.05%
115	Holland family, deep, 0–20% slopes	120.0	3.59%
117	Holland family, deep, 40–60% slopes	71.2	2.13%
119	Holland family, deep – Holland families complex 20–40% slopes	163.5	4.90%
120	Holland family, deep – Holland family complex, 40–60% slopes	28.6	0.86%
123	Holland, deep – Marpa families complex, 20–40% slopes	86.8	2.60%
174	Marpa family, 20–40% slopes	150.5	4.51%
175	Marpa family, 40–60% slopes	17.0	0.51%
177	Marpa-Chawanakee families complex, 40–60% slopes	3.1	0.09%
178	Marpa-Goulding families association, 20–40% slopes	107.6	3.22%
179	Marpa-Goulding families association, 40–60% slopes	545.8	16.34%
180	Marpa-Goulding families association, 60–80% slopes	11.7	0.35%
182	Marpa-Holland, deep families complex, 20–40% slopes	247.0	7.40%
183	Marpa-Holland, deep families complex, 40–60% slopes	167.2	5.01%
195	Millsholm family, 20–60% slopes	36.7	1.10%
204	Neuns family, 60–80% slopes	19.4	0.58%
250	Rock outcrop, limestone	43.3	1.30%
259	Rock outcrop – Goulding family complex, 40–80% slopes	20.1	0.60%
AtE2sh	Auburn very stony clay loam, 30–50% slopes, eroded	2.7	0.08%
BoF3sh	Boomer very stony clay loam, 50–70% slopes, severely eroded	43.6	1.30%
W	Water	28.6	0.86%

Soil Biomass Productivity Soil biomass productivity in the Shasta-Trinity National Forest (STNF) ranges from nonproductive to high (USFS 1994). Using Forest Service Site Class (FSSC) as a surrogate metric for soil biomass productivity, approximately 36 percent of the Shasta Lake and vicinity area is occupied by soils of low biomass productivity, about 39 percent by soils of moderate productivity, and about 13 percent by "nonproductive" soils and miscellaneous land types (e.g., rock outcrop). Soils of high biomass productivity are unlikely to occur in the Shasta Lake and vicinity area.

Soil Susceptibility to Erosion (Uplands) Interpretations of soil susceptibility to erosion are presented in Table 4-11 for the portion of the area between 1,070 feet and 1,090 feet above msl (Impoundment Area), and in Table 4-12 for the portion potentially disturbed by construction activities. Of the approximately 4,881.36 acres in the Shasta Lake and vicinity area, 4,481 acres (92 percent of total area) are assigned a hazard rating of severe.

Table 4-11. Summary of Soil Erosion Hazard – Shasta Lake and Vicinity (Impoundment Area)

Soil Erosion Hazard	Acres	% of Total Subarea)
Moderate	38.55	1.54%
Severe	2248.81	90.03%
Not Rated	210.00	8.41%

Table 4-12. Summary of Soil Erosion Hazard – Shasta Lake and Vicinity (Relocation Areas)

Soil Erosion Hazard	Acres	% of Total Subarea
Moderate	85.59	3.59%
Severe	2232.61	93.65%
Not Rated	65.80	2.76%

Soil Susceptibility to Erosion (Shoreline) There are more than 420 miles of shoreline around Shasta Lake. As described below under "Methods and Assumptions," a conceptual model was developed to estimate current erosion rates and predict future erosion rates (see Attachment 1, Shoreline Erosion Technical Memorandum). Data for the model were collected synoptically in 2002, 2004, 2007, and 2013, providing a "snapshot" of shoreline conditions. This analysis of shoreline erosion provides an insight into the potential for erosion as the reservoir level rises. Validation of the model will come with statistically unbiased sampling and analyses that can occur during mitigation.

Based on the model output, about 18 percent of the shoreline has a low severity rating for erosion potential for the first 15 years, when most of the erosion would take place. The remaining shoreline has a moderate (58 percent) to high (23 percent) severity rating for erosion potential. Most of the shoreline that is exposed during routine drawdown periods (i.e., drawdown zone) has been subject to substantial erosion, and very little soil remains after more than 60 years of reservoir operations.

Soil Susceptibility to Subsidence Published interpretations of soil susceptibility to subsidence are generally not available for the Shasta Lake and vicinity area. The likelihood that subsidence would occur as a result of decomposition of soil organic matter is low because of the absence of soils derived from peaty or mucky parent materials. Similarly, the likelihood of subsidence caused by aquifer-system compaction is low because of the absence of significant, widespread groundwater withdrawal in the Shasta Lake and vicinity area. Land subsidence has the potential to occur in areas underlain by highly weatherable, carbonate-rich rocks (e.g., certain limestones), and in areas affected by underground construction.

Soil Susceptibility to Liquefaction Published interpretations of soil susceptibility to liquefaction are generally not available for the Shasta Lake and vicinity area. The likelihood that soil liquefaction would occur is low because of the absence of the necessary high-groundwater conditions in the Shasta Lake and vicinity area.

Soil Susceptibility to Expansion Published interpretations of soil susceptibility to expansion (i.e., shrinking and swelling) are generally not available for most of the Shasta Lake and vicinity area. The likelihood that expansive soils occur is low because the weathering products derived from the local bedrock typically contain low concentrations of “active” clays (e.g., montmorillonite).

Soil Suitability for On-site Application of Waste Material Published interpretations of soil suitability for on-site application of waste material (i.e., capability to support use of septic tanks or alternative wastewater disposal systems) are generally not available for the Shasta Lake and vicinity area. In general, soils in the Shasta Lake and vicinity area are poorly suited to these uses because of shallow soil depth, high rock content, and excessive slope.

Upper Sacramento River (Shasta Dam to Red Bluff)

The following section describes the susceptibility of soil in the upper Sacramento River portion of the primary study area to erosion (channel shoreline), erosion (wind), subsidence, liquefaction, and expansion.

Soils in the Sacramento River basin are divided into four physiographic groups: upland soils, terrace soils, valley land soils, and valley basin soils. Upland soils are prevalent in the hills and mountains of the region and are composed mainly of sedimentary sandstones, shales, and conglomerates originating from igneous rocks. Terrace and upland soils are predominant between Redding and Red Bluff; however, valley land soils border the Sacramento River through this area. Valley land and valley basin soils occupy most of the Sacramento Valley floor south of Red Bluff. Valley land soils consist of deep alluvial and aeolian soils that make up some of the best agricultural land in the state. The valley floor was once covered by an inland sea, and sediments were formed by deposits of marine silt followed by mild uplifting earth movements. After the main body of water disappeared, the Sacramento River began eroding and redepositing silt and sand in new alluvial fans.

Soil Susceptibility to Erosion (Channel Shoreline) Shasta and Keswick dams have a significant influence on sediment transport in the Sacramento River because they block sediment that would normally be transported downstream. The result has been a net loss of coarse sediment, including salmon spawning gravels, in the Sacramento River below Keswick Dam. In alluvial river sections, bank erosion and sediment deposition cause river channel migrations that are vital to maintaining instream and riparian habitats, but which can cause loss of agricultural lands and damage to roads and other structures.

Soil Susceptibility to Erosion (Wind) Soil erodibility, climatic factors, soil surface roughness, width of field, and quantity of vegetative coverage affect the susceptibility of soils to wind erosion. Wind erosion leaves the soils shallower and can remove organic matter and needed plant nutrients. In addition, blowing soil particles can damage plants, particularly young plants. Blowing soils also can cause off-site problems such as reduced visibility and increased allergic reaction to dust.

Soil Susceptibility to Subsidence Land subsidence in the Sacramento Valley is localized and concentrated in areas of overdraft from groundwater pumping. Land subsidence had exceeded 1 foot by 1973 in two main areas in the southwestern part of the valley near Davis and Zamora; however, additional subsidence since then has not been reported.

Soil Susceptibility to Expansion Most of Shasta County is characterized by moderately expansive soils with areas of low expansiveness in the South Central Region and southeastern corner of the county. Small scattered areas of highly expansive soils exist in the mountains of the Western Upland, French Gulch, and North East Shasta County planning areas. The hazard associated with expansive soils is that areas of varying moisture or soil conditions can differentially expand or shrink, causing stresses on structures that lead to cracking or settling. Effects of expansive soils on structures can be mitigated by requiring proper engineering design and standard corrective measures.

Lower Sacramento River and Delta

The following section describes the susceptibility of soil in the lower Sacramento River and Delta portion of the extended study area to erosion (channel shoreline), erosion (wind), subsidence, liquefaction, and expansion.

The soils of the Sacramento River basin are divided into four physiographic groups, as described above for the upper Sacramento River portion of the study area.

The soils of the Delta region vary primarily as a result of differences in geomorphological processes, climate, parent material, biological activity, topography, and time. The soils are divided into the following four general soil types:

- Delta organic soils and highly organic mineral soils
- Sacramento River and San Joaquin River deltaic soils
- Basin and basin rim soils
- Moderately well to well-drained valley, terrace, and upland soils

The Delta region contains soils primarily with the required physical and chemical soil characteristics, growing season, drainage, and moisture supply necessary to qualify as Prime Farmland. This includes 80–90 percent of the area of organic and highly organic mineral soils, Sacramento River and San Joaquin River deltaic soils, and basin and basin rim soils. Most of the remaining soils of the Delta region qualify as Farmland of Statewide Importance.

Soil Susceptibility to Erosion (Channel Shoreline) In the extended study area, the Sacramento River is a major alluvial river section that is active and sinuous, meandering across alluvial deposits within a wide meander belt. In alluvial river sections, bank erosion and sediment deposition cause migrations of the river channel. These migrations are extremely important in maintaining instream and riparian habitats, but also can cause loss of agricultural lands and damage to roads and other structures. Geologic outcroppings and human-made structures, such as bridges and levees, act as local hydraulic controls along the river. Bank protection, consisting primarily of rock riprap, has been placed along various sections of the Sacramento River to reduce erosion and river meandering.

The great quantities of sediment transported by the rivers into the Delta move primarily as suspended load. Of the estimated 5 million tons per year of sediment inflow into the Delta, about 80 percent originates from the Sacramento River and San Joaquin River drainages; the remainder is contributed by local streams. Approximately 15–30 percent of the sediment is deposited in the Delta; the balance moves into the San Francisco Bay system or out through CVP and SWP facilities.

Soil Susceptibility to Erosion (Wind) The Delta's organic soils and highly organic mineral soils have wind erodibility ratings of 2–4 on a scale where 1 is most erodible and 8 is least erodible. The high wind erodibility of Delta soils is caused by the organic matter content of the soil. The rate of wind erosion is estimated at 0.1 inch per year.

Soil Susceptibility to Subsidence Subsidence of the Delta's organic soils and highly organic mineral soils is attributable primarily to biochemical oxidation of organic soil material as a result of long-term drainage and flood protection. The highest rates of subsidence occur in the central Delta islands, where organic matter content in the soils is highest.

Development of the islands resulted in subsidence of the islands' interiors and greater susceptibility of the topsoil to wind erosion. Subsidence, as it relates to Delta islands, refers generally to the falling level of the land surface from primarily the oxidation of peat soil. Levee settlement may be partially caused by peat oxidation if land adjacent to levees is not protected from subsidence.

Soil Susceptibility to Expansion Soils in the lower Sacramento River and Delta portion of the extended study area vary from having low to high shrink-swell potential. In general, soils in the narrow corridor upstream along the Sacramento River have low shrink-swell potential according the U.S. Department of Agriculture's State Soil Geographic (STATSGO) Database Soil Surveys, with the exception of some soils with moderate shrink-swell potential near the Red Bluff Pumping Plant (NRCS 1995). Downstream, the shrink-swell potential of soils near the Delta is generally classified by the STATSGO Soil Surveys as "high." The hazard associated with expansive soils is that areas of varying moisture or soil conditions can differentially expand or shrink, causing stresses on structures that lead to cracking or settling. This hazard is identifiable through standard soil tests. Its effects on structures can be mitigated through the requirements of proper engineering design and standard corrective measures.

CVP/SWP Service Areas

As described above for the upper Sacramento River portion of the primary study area, soils in the CVP/SWP service areas are divided into four physiographic groups: valley land, valley basin, terrace land, and upland soils. According to the U.S. Department of Agriculture's STATSGO Database, soils within the CVP/SWP service areas consist of clay, loam, silt, and sand, some of which is gravelly. The CVP/SWP service areas also consist of unweathered and weathered bedrock that is evident through outcrops at the ground surface (NRCS 1995).

4.2 Regulatory Framework

The following section describes the Federal, State of California (State), and local regulatory setting for geological resources.

4.2.1 Federal

This section discusses the Federal regulatory setting for water quality, runoff, air quality, earthquakes, paleontological resources, and natural resources.

Clean Water Act

The Clean Water Act (CWA) includes provisions for reducing soil erosion for the protection of water quality. The CWA makes it unlawful for any person to discharge pollutants from a point source (including construction sites) into navigable waters, unless a permit has been obtained under its provisions. This pertains to construction sites where soil erosion and storm runoff and other pollutant discharges could affect downstream water quality.

National Pollutant Discharge Elimination System

The National Pollutant Discharge Elimination System process, established by the CWA, is intended to meet the goal of preventing or reducing pollutant runoff. Projects involving construction activities (e.g., clearing, grading, or excavation) with land disturbance greater than 1 acre must file a notice of intent with the applicable regional water quality control board (RWQCB) to indicate the intent to comply with the State General Permit for Storm Water Discharges Associated with Construction Activity. This permit establishes conditions to minimize sediment and pollutant loading and requires preparation and implementation of a stormwater pollution prevention plan (SWPPP) before construction.

Clean Air Act

The Clean Air Act also has provisions for reducing soil erosion relevant to air and water quality. On construction sites, exposed soil surfaces are vulnerable to wind erosion, and small soil particulates are carried into the atmosphere. Suspended particulate matter (consisting of PM_{10} and $PM_{2.5}$, as defined in Chapter 5, “Air Quality and Climate”) is one of the six criteria air pollutants of the Clean Air Act.

Earthquake Hazards Reduction Act

In October 1977, the U.S. Congress passed the Earthquake Hazards Reduction Act to “reduce the risks to life and property from future earthquakes in the United States through the establishment and maintenance of an effective earthquake hazards and reduction program.” To accomplish this, the act established the National Earthquake Hazards Reduction Program. The National Earthquake Hazards Reduction Program Act (NEHRPA) significantly amended this program in November 1990 by refining the description of agency responsibilities, program goals, and objectives. The NEHRPA designates the Federal Emergency Management Agency as the lead agency of the program and assigns it several planning, coordinating, and reporting responsibilities. Other NEHRPA agencies include the National Institute of Standards and Technology, the National Science Foundation, and U.S. Geological Survey.

Antiquities Act of 1906

Federal protection for significant paleontological resources would apply to the project if any construction or other related project impacts occurred on Federally owned or managed lands. Federal legislative protection for paleontological resources stems from the Antiquities Act of 1906 (Public Law

59-209; 16 U.S. Code 431 et seq.; 34 Stat. 225), which calls for protection of historic landmarks, historic and prehistoric structures, and other objects of historic or scientific interest on federal land.

Federal Cave Resource Protection Act of 1988

Cave and karst landform resources are provided Federal protection under the Federal Cave Resource Protection Act of 1988. Although not a legally binding agreement, the Interagency Agreement for Collaboration and Coordination in Cave and Karst Resources signed by U.S. Department of the Interior and U.S. Department of Agriculture land management agencies provides guidelines for the management, research, conservation, and protection of these resources.

Shasta-Trinity National Forest Land and Resource Management Plan

The STNF Land and Resource Management Plan (LRMP) (USFS 1995) contains forest goals, standards, and guidelines designed to guide the management of the STNF. The following goals, standards, and guidelines related to geologic and seismic hazards and soils issues associated with the study area were excerpted from the STNF LRMP.

- Goals (LRMP, p. 4-5):
  - Maintain or improve soil productivity and prevent excessive surface erosion, mass wasting, and cumulative watershed impacts.
- Standard and Guidelines (LRMP, p. 4-25):
  - Determine the sensitivity of each 2nd or 3rd order watershed using soil, geologic, and streamflow characteristics.
  - Implement Forest Soil Quality Standards and Best Management Practices for areas identified as having highly erodible soils. Specifically, apply the special practices dealing with timber harvest, site preparation, and road construction in highly erodible soils.
  - Forest Soil Quality Standards in relation to ground cover, soil organic matter, and soil porosity will be used to protect soil productivity (as referenced in Appendix O of the LRMP).

U.S. Bureau of Land Management Resource Management Plan

The U.S. Department of the Interior, Bureau of Land Management (BLM) Resource Management Plan, which is its plan for managing federal lands in Shasta County, was amended by the 1994 Record of Decision for the Northwest Forest Plan (Final Supplemental EIS for Amendments to USFS and BLM Planning Documents within the Range of the Northern Spotted Owl). This amendment required preparation of watershed analyses before initiating BLM activities. As a party to the Northwest Forest Plan, BLM, like USFS, is also required to ensure that projects are consistent with the Aquatic Conservation Strategy.

Federal Minerals Management

Mineral development is permitted on all public lands not withdrawn from mineral entry. The U.S. Mining Laws (30 U.S. Code 21–54) confer statutory right to enter upon public lands in search of minerals. Regulations found in 36 Code of Federal Regulations 228, Subpart A, set forth rules and procedures to minimize adverse environmental impacts on national forest resources. Access for mineral exploration and development is generally unrestricted, subject to the mitigation of adverse impacts on surface resources.

Access for mineral exploration on STNF land is restricted in wildernesses, the “wild” portions of wild and scenic rivers, botanical areas, Research Natural Areas, NRAs, and areas that have been withdrawn from mineral entry. Minerals in the Whiskeytown-Shasta-Trinity NRA are not locatable (minerals that may be acquired under the Mining Law of 1872, as amended), but they are leasable (USFS 1994).

Access for mineral-related activities to wilderness, the NRA, and other lands typically withdrawn from mineral entry is subject to valid existing rights. The type of access authorized must be consistent with the proposed use and of a type that would maintain the special character of the areas to the fullest extent possible.

The Federal lands within the Shasta Unit of the Whiskeytown-Shasta-Trinity NRA were withdrawn from mineral entry under the 1872 Mining Law by the NRA legislation, subject to valid existing rights. Seven claims in the NRA predate the withdrawal. Currently, there are no approved operating plans for these seven mining claims. The lands covered by these claims remain open to mineral leasing. Hard rock minerals in the NRA are available for prospecting, exploration, and development under solid mineral leasing regulations (43 Code of Federal Regulations (CFR) Subpart 3583). Authorization for this land use requires permits and leases subject to approval by the Secretary of Agriculture and terms and conditions of the USFS to protect the values of the NRA.

4.2.2 State

This section discusses the State regulatory setting for soil erosion, water quality, earthquakes, mining, air quality (related to asbestos), paleontological resources, and building design.

Porter-Cologne Act

State regulations, including the Porter-Cologne Act and California Fish and Game Code Section 1600, have provisions to reduce soil erosion. The Porter-Cologne Act established the State Water Resources Control Board and nine RWQCBs that regulate water quality. The RWQCBs carry out the National

Pollutant Discharge Elimination System permitting process for point source discharges and the CWA Section 401 certification program.

California Fish and Game Code Section 1600

California Fish and Game Code Section 1600 requires notification for projects that are planned to occur in, or in close proximity to, a river, stream, or lake, or their tributaries. Applicants are to enter into a "streambed alteration agreement" with the CDFW when a construction activity would (1) divert, obstruct, or change the natural flow or the bed, channel, or bank of any river, stream, or lake; (2) use material from a streambed; or (3) result in the disposal of debris, waste, or other material containing crumbled, flaked, or ground pavement that could pass into a river, stream, or lake. The Federal government is not required to submit a Fish and Game Code 1600 permit; however, the same impacts will be addressed under CWA Section 401 and 404 permits.

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Act (California Public Resources Code Section 2621 et seq.) was passed by the California Legislature to mitigate the hazard of surface faulting to structures. The act's main purpose is to prevent the construction of buildings used for human occupancy on the surface trace of active faults. The act addresses only the hazard of surface fault rupture and is not directed toward other earthquake hazards. Local agencies must regulate most development in fault zones established by the State Geologist. Before a project can be permitted in a designated Alquist-Priolo Earthquake Fault Zone, cities and counties must require a geologic investigation to demonstrate that proposed buildings would not be constructed across active faults.

1990 Seismic Hazards Mapping Act

The 1990 Seismic Hazards Mapping Act (California Public Resources Code Sections 2690 through 2699.6) addresses strong ground shaking, liquefaction, landslides, or other ground failures as a result of earthquakes. This act requires statewide identification and mapping of seismic hazard zones, which would be used by cities and counties to adequately prepare the safety element of their general plans and protect public health and safety (California Geological Survey 2003). Local agencies are also required to regulate development in any seismic hazard zones, primarily through permitting. Permits for development projects are not issued until geologic investigations have been completed and mitigation measures have been developed to address identified issues.

Surface Mining and Reclamation Act of 1975

The Surface Mining and Reclamation Act of 1975 (California Public Resources Code Section 2710 et seq.) addresses surface mining and requires mitigation to reduce adverse impacts on public health, property, and the environment. The Surface Mining and Reclamation Act applies to anyone (including a government agency) that disturbs more than 1 acre or removes more than 1,000 cubic yards of material through surface mining activities, even if activities occur on Federally managed lands (CDMG 2006b). Local city and county "lead agencies" develop ordinances for permitting that provide the regulatory framework for mining and reclamation activities. The permit generally includes a permit to mine, a reclamation plan to return the land to a useable condition, and financial reports to ensure reclamation would be feasible. The State Mining and Geology Board reviews lead agency ordinances to ensure they comply with Surface Mining and Reclamation Act (CDMG 2006b).

Asbestos Airborne Toxic Control Measure for Construction, Grading, Quarrying, and Surface Mining Operations

The Asbestos Airborne Toxic Control Measure for Construction, Grading, Quarrying, and Surface Mining Operations (Title 17, California Code of Regulations (CCR) Section 93105 (17 CCR Section 93105)) contains the requirements for construction operations that would disturb any portion of an area that is located in a geographic ultramafic rock unit or that has naturally occurring asbestos, serpentine, or ultramafic rock. Construction or grading operations on property where the area to be disturbed is greater than 1 acre require that an asbestos dust mitigation plan be submitted and approved by the air quality management district before the start of construction. The asbestos dust mitigation plan must be implemented at the beginning and must be maintained throughout the operation. To receive an exemption from this asbestos airborne toxic control measure, a State-registered professional geologist must conduct a geologic evaluation of the property and determine that no serpentine or ultramafic rock is likely to be found in the area to be disturbed. This report must be presented to the executive officer or air pollution control officer of the air pollution control or air quality management district, who may then grant or deny the exemption.

Asbestos Airborne Toxic Control Measure for Surfacing Applications

The Asbestos Airborne Toxic Control Measure for Surfacing Applications (17 CCR Section 93106) applies to any person who produces, sells, supplies, offers for sale or supply, uses, applies, or transports any aggregate material extracted from property where any portion of the property is located in a geographic ultramafic rock unit or the material has been determined to be ultramafic rock, or serpentine, or material that has an asbestos content of 0.25 percent or greater. Unless exempt, the use, sale, application, or transport of material for surfacing is restricted, unless it has been tested using an approved asbestos bulk test method and determined to have an asbestos content that is less than 0.25 percent. Any recipient of such materials may need to be provided a receipt with the quantity of materials, the date of the sale, verification that the asbestos content is less than 0.25 percent, and a warning label. Anyone involved in the transportation of the material must keep copies of all receipts with the materials at all times.

California Public Resources Code Chapter 1.7

No State or local agency requires a paleontological collecting permit to allow for the recovery of fossil remains discovered as a result of construction-related earthmoving on State or private land in a project site. California Public

Resources Code Chapter 1.7 (Archaeological, Paleontological, and Historical Sites), Section 5097.3, specifies that State agencies may undertake surveys, excavations, or other operations as necessary on State lands to preserve or record paleontological resources.

California Building Standards Code

The State of California provides minimum standards for building design through the California Building Standards Code (CBC) (see Title 24, Part 2, Table 18-1-B). Where no other building codes apply, Chapter 29 regulates excavation, foundations, and retaining walls. The CBC also applies to building design and construction in the State and is based on the Federal Uniform Building Code used widely throughout the country (generally adopted on a state-by-state or district-by-district basis). The CBC has been modified for California conditions with numerous more detailed and/or more stringent regulations.

The State's earthquake protection law (California Health and Safety Code, Section 19100 et seq.) requires that structures be designed to resist stresses produced by lateral forces caused by wind and earthquakes. Specific minimum seismic safety and structural design requirements are set forth in Chapter 16 of the CBC. The CBC identifies seismic factors that must be considered in structural design.

Chapter 18 of the CBC regulates the excavation of foundations and retaining walls, and Appendix Chapter A33 regulates grading activities, including drainage and erosion control, and construction on unstable soils such as expansive soils and liquefaction areas.

4.2.3 Regional and Local

The following section describes the regional and local regulatory setting for geological resources.

County General Plans

Section 65302(g) of the California Government Code requires that county general plans include an element that identifies and appraises seismic and geologic hazards.

Seismic hazards that must be addressed in this section include the following:

- Surface faulting
- Ground shaking
- Ground failure

Nonseismic hazards addressed include the following:

- Volcanoes

- Erosion
- Expansive soils

Local Guiding Ordinances

In addition to identifying and appraising seismic and geologic hazards, counties and municipalities in the project study area also commonly set requirements for grading and erosion control, including prevention of sedimentation or damage to off-site property. Usually these requirements are established via a grading ordinance, which is administered through issuance of grading permits. Grading permits typically require a vested map and the following information:

- Detailed grading plan
- Geological studies, if the project is located within an area prone to slippage, having highly erodible soils, or of known geologic hazards
- Detailed drainage or flood control information as required by the department of public works
- Final plan for development, if the project is located in a zone district that requires a final development plan
- Noise analysis, if the project is located in the vicinity of a high-noise-generating use

4.3 Environmental Consequences and Mitigation Measures

This section discusses environmental consequences on geology, geologic hazards, geomorphology, minerals, and soils associated with implementation of the project alternatives. It also describes potential mitigation measures associated with impacts on geology that are significant or potentially significant.

4.3.1 Methods and Assumptions

In general, the analysis presented in this section is qualitative and is based on general information on geology, geologic hazards, geomorphology, minerals, and soils, as reported in Section 4.1. Environmental consequences associated with geologic resources that could result from implementing alternatives were evaluated qualitatively based on expected construction methods; environmental commitments common to all action alternatives; and the locations, materials, and durations of project construction and related activities.

As described in following paragraphs, for the Shasta Lake and vicinity portion of the primary study area, more quantitative analyses were undertaken to address geomorphology (i.e., stream characteristics in watersheds that are adjacent and directly tributary to Shasta Lake) (also see Section 4.1.3) and shoreline erosion (also see Section 4.1.5).

Geomorphology

The analysis of fluvial characteristics of watersheds that are adjacent and directly tributary to Shasta Lake evaluated the impact of raising Shasta Dam on stream channel equilibrium, focusing on the balance between sediment transport capacity and channel stability. The average gradient and flow regime of a watercourse are often the variables that control the sediment transport capacity of a given stream channel. The flow regime of a stream is determined by the measure of the average flow of surface water. The average estimated mean annual flow among all intermittent streams calculated using Net Trace software was 0.7 cubic feet per second (cfs), ranging from 0.15 to 2.89 cfs. Any stream that has a predicted average annual flow above 3 cfs was assumed to function as a perennial stream, and any stream with a predicted flow of less than 3 cfs was assumed to function as an intermittent stream.

Typically, over time, streams reach a natural state of equilibrium based on their gradient and sediment transport capacity. Raising the water level of Shasta Lake may affect the equilibrium of watercourses that are controlled by the present reservoir level. Raising the dam may destabilize these streams by altering the length of stream that will be incorporated into the drawdown. Raising the dam will affect the gradient of adjacent watercourses by altering the length of the watercourse and the change in elevation due to seasonal fluctuations in lake water levels. This is the rationale behind analyzing the gradient and flow regime of watercourses that are adjacent and directly tributary to Shasta Lake.

The stream networks in the Shasta Lake and vicinity area were characterized using the Net Trace model generated in a geographic information system (GIS) environment. Net Trace was used because existing California and USFS stream layers lack the level of detail and necessary variables needed to assess the impact of raising the water level of Shasta Lake on stream channel equilibrium. Initially, sub-10-meter digital elevation models covering the Shasta Lake and vicinity were imported into GIS. Using the methods described in programs for digital elevation model analysis (Miller 2003), a surface stream network with user-selected attributes was created using Net Trace. The following characteristics were then calculated for each stream segment: drainage area, riparian area, length, flow direction (degrees), stream order, elevation, gradient statistics, mean precipitation, and mean annual stream flow (cfs).

To verify the accuracy of the Net Trace stream model, the measured bed gradient along surveyed transects on Squaw Creek and Big Backbone Creek was compared to the modeled gradient values calculated by Net Trace along the same transect. The combined average difference between the measured and modeled bed gradient was approximately 4.5 percent, meaning that the measured stream bed gradient is steeper than the modeled gradient. A bias in the sampling distribution is the cause of the disparity. For example, 22 segments were surveyed along the Squaw Creek transect and used to determine the measured bed gradient; however, only 5 segments were available from the Net Trace model to calculate the gradient. Simply, the surveyed transects were measured at greater level of detail than were calculated in the Net Trace model.

Although the surveyed gradient values are more accurate than the modeled values, it would be impractical to survey every watercourse within a study area as large as that of the SLWRI. A more reasonable approach to developing a systematic characterization of the stream network was to compare the surveyed water surface gradient to the modeled values. This approach eliminates the topographic details of the streambed surface and measures the surface gradient of the stream over the entire transect. The combined average difference between the measured surface gradient and modeled bed gradient was about 2 percent, meaning the measured stream bed gradient is 2 percent steeper than the modeled gradient. Although this disparity is noteworthy, the modeled stream network is considered a first-iteration representation of the hydrologic system of the study area, and the lower gradient values produce a more conservative estimate of sediment transport within the system. These results suggest that the digital elevation model-generated stream network is detailed enough to be used as a measure of the potential impacts of raising Shasta Dam on stream channel equilibrium.

Using GIS, the Net Trace stream network was intersected with polygons representative of shoreline area affected through the inundation by each alternative. These intersections were completed for each arm of Shasta Lake. The total stream length and riparian area affected by the inundation were calculated for each arm and summarized to calculate the value for the entire shoreline of Shasta Lake. The affected stream length and riparian areas were also calculated in further detail for perennial and intermittent streams by stream-gradient categories of less than or greater than 10 percent.

Soil Erosion (Shoreline)

A conceptual model was developed to predict the rate and volume of shoreline erosion. The methods and assumptions used for the model are described in Attachment 1, "Shoreline Erosion Technical Memorandum." The conceptual model represents the spatial and temporal components of shoreline erosion, and was developed as a framework for field investigations, estimating present erosion rates, and predicting future erosion rates. The process-based model characterizes the causes of shoreline erosion and uses types of erosion initiation to weight the erodibility of the shoreline. The model was developed using results from similar studies; available precipitation, wind, and lake level data; information concerning the engineering properties of the bedrock geology and soils; the shoreline and hillslope topography; measured erosion processes and rates from sequential historical aerial photographs; and field investigations. Because there were very few shoreline erosion studies for reservoirs as large as Shasta Lake to use as background and support for the analysis, readily available references were used to help characterize the process of shoreline erosion, verify the predicted shoreline erosion rates, and design mitigation measures.

The model divided the shoreline into two zones, which helped account for the episodic nature of erosional events. The nearshore zone is classified as the area above the 1,070-foot contour, and represents the “bathtub” ring around the reservoir. The drawdown zone is classified as the area between the 1,070-foot contour and the 1,020-foot contour. The latter contour was used to represent the drawdown level that typically occurs to meet USACE requirements for flood storage capacity. The nearshore zone is eroded by wave action when the reservoir is full. During drawdown periods, this zone erodes as a result of upland surface runoff, subsurface flow, and fluvial incision along stream channels and gullies.

To represent the temporal component of shoreline erosion, the model was compartmentalized so that shoreline development could be evaluated in three time steps. The first step lasts for about 15 years and is when most of the erosion occurs (Morris and Fan 1997). During this time, the inundated soils are fully saturated; as a result, they may lose cohesion and are subject to rapid erosion, transport, and deposition. Shoreline exposed in the drawdown zone is typically eroded to bedrock or to resilient soil layers, leaving an exposed surface that supports little vegetation. Within this zone, stream channels and gullies rapidly incise the underlying soil and rock.

The second time step can last between about 0 and 150 years. During this time, stable shoreline topography is developing through a sequence of slope-forming events. For modeling purposes, the types of slope-forming events were classified by lithotopo unit because several common processes initiate and control erosion. The shoreline erosion survey data suggest that stable hillslopes are typically associated with shallow soils on coherent bedrock, forming steep topography (greater than 65 percent slope gradient). Unstable hillslopes are associated with deep soils on moderately steep areas (between 30 percent and 65 percent). Around Shasta Lake, stable shoreline formed rapidly during the first 15 years of lake management. Conversely, about 60 years later, unstable hillslopes are still responding to erosional forces and, in some locations, continue to erode at a very high rate (greater than 900 cubic yards/acre/year).

The third time step is used to represent a period when the shoreline slope is stable and soil shear strength remains greater than the shear stresses acting on the slope. During this time, the erosion rate continues to decrease and eventually equals the upslope erosion rates. The analysis assumes that most of the shoreline around Shasta Lake will become stable as the reservoir ages, and the data show that about half of the shoreline is presently stable.

4.3.2 Criteria for Determining Significance of Effects

An environmental document prepared to comply with NEPA must consider the context and intensity of the environmental consequences that would be caused by, or result from, the proposed action. Under NEPA, the significance of an environmental consequence is used solely to determine whether an EIS must be prepared. An environmental document prepared to comply with CEQA must identify the potentially significant environmental effects of a proposed project. A “[s]ignificant effect on the environment” means a substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by the project (State CEQA Guidelines, Section 15382). CEQA also requires that the environmental document propose feasible measures to avoid or substantially reduce significant environmental effects (State CEQA Guidelines, Section 15126.4(a)).

The following significance criteria were developed based on guidance provided by the State CEQA Guidelines, and consider the context and intensity of the environmental effects as required under NEPA. At a minimum, impacts of an alternative on geology, geologic hazards, geomorphology, mineral resources, and soils would be significant under CEQA if project implementation would do any of the following:

- Expose people or structures to potential substantial adverse effects, including the risk of loss, or injury, or death involving the following:
    - Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault
    - Strong seismic ground shaking
    - Seismic-related ground failure, including liquefaction
    - Landslides
- Result in substantial soil erosion or loss of topsoil
- Locate project facilities on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse
- Locate project facilities on expansive soil, as defined in Table 18-1-B of the Uniform Building Code, creating substantial risks to life or property
- Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for disposal of wastewater

- Result in the loss or availability of known mineral resources that would be of future value to the region

Significance statements are relative to both existing conditions (2005) and future conditions (2030), unless stated otherwise.

4.3.3 Topics Eliminated from Further Discussion

The topics of snow avalanches, expansive soil, and soil liquefaction are eliminated from the discussion of environmental consequences owing to the low likelihood of their occurrence as previously discussed (see Section 4.1.2 for snow avalanches and Section 4.15 for other eliminated topics).

Paleontological resources are not included in the discussion of environmental consequences. As described in Section 4.1.1, a small area of the fossiliferous Cretaceous Chico Formation occurs near Jones Valley Creek, a tributary to the Pit Arm, but this rock unit is not exposed along the shoreline of the lake and is not associated with any relocation area. Some outcrops of McCloud Limestone, especially in the vicinity of the McCloud River Bridge, also contain fossil corals and other microinvertebrates. Some areas underlain by limestone are likely to be disturbed regardless of the action alternative being considered. However, the fossils that compose the McCloud Limestone are well documented in the scientific literature, and it is unlikely that paleontological resources of scientific or cultural significance occur in this formation. In the event that an unanticipated discovery of paleontological resources occurs, the environmental commitments described in Chapter 2 will be applied.

Paleontological resources have been eliminated from further discussion in the upper Sacramento River (Shasta Dam to Red Bluff), lower Sacramento River and Delta, and CVP/SWP service areas because no impacts are anticipated to these resources as a result of reoperation of the dam.

4.3.4 Direct and Indirect Effects

The following section describes the potential environmental consequences of the project, and impacts and mitigation measures.

No-Action Alternative

This section describes potential impacts that would occur under the NEPA No-Action Alternative. Under the No-Action Alternative, no additional Federal action would be taken to address water reliability issues or increase anadromous fish survival. Shasta Dam would not be modified, and the CVP would continue operating similar to the existing condition. No new construction would occur under the No-Action Alternative and the full pool elevation of the reservoir would remain at approximately 1,070 feet above msl.

Shasta Lake and Vicinity This section describes impacts on the Shasta Lake and vicinity portion of the primary study area.

Impact Geo-1 (No-Action): Exposure of Structures and People to Geologic Hazards Resulting from Seismic Conditions, Slope Instability, and Volcanic Eruption Under the No-Action Alternative, no new construction would occur and the full pool level would not be increased. Therefore, there would be no increase in the risk of geologic hazards to people or structures. No impact would occur. Mitigation is not required for the No-Action Alternative.

Impact Geo-2 (No-Action): Alteration of Fluvial Geomorphology and Hydrology of Aquatic Habitats Under the No-Action Alternative, the full pool level would not be increased. Therefore, the ongoing changes to aquatic habitat within the existing transitional riverine habitat would continue, specifically, periodic adjustments to the bed and banks of stream channels in response to lake level fluctuations and upstream geomorphic processes. Any habitat benefits that may occur as a result of structural changes (e.g., recruitment of large wood or coarse sediment) would be dynamic and subject to change over time. No impact would occur. Mitigation is not required for the No-Action Alternative.

Impact Geo-3 (No-Action): Loss or Diminished Availability of Known Mineral Resources that Would Be of Future Value to the Region Under the No-Action Alternative, no new construction would occur and the full pool level would not be increased. Therefore, there would be no loss or diminished availability of known mineral resources that would be of future value to the region. No impact would occur. Mitigation is not required for the No-Action Alternative.

Impact Geo-4 (No-Action): Lost or Diminished Soil Biomass Productivity Under the No-Action Alternative, no new construction would occur and the full pool level would not be increased. Therefore, there would be no lost or diminished soil biomass productivity. No impact would occur. Mitigation is not required for the No-Action Alternative.

Impact Geo-5 (No-Action): Substantial Soil Erosion or Loss of Topsoil Due to Shoreline Processes Under the No-Action Alternative, the full pool level would not be increased. Therefore, there would be no increase in soil erosion or loss of topsoil due to shoreline processes. No impact would occur. Mitigation is not required for the No-Action Alternative.

Impact Geo-6 (No-Action): Substantial Soil Erosion or Loss of Topsoil Due to Upland Processes Under the No-Action Alternative, there would be no disturbance of upland landscape positions. Therefore, there would be no increase in soil erosion or loss of topsoil due to upland processes. No impact would occur. Mitigation is not required for the No-Action Alternative.

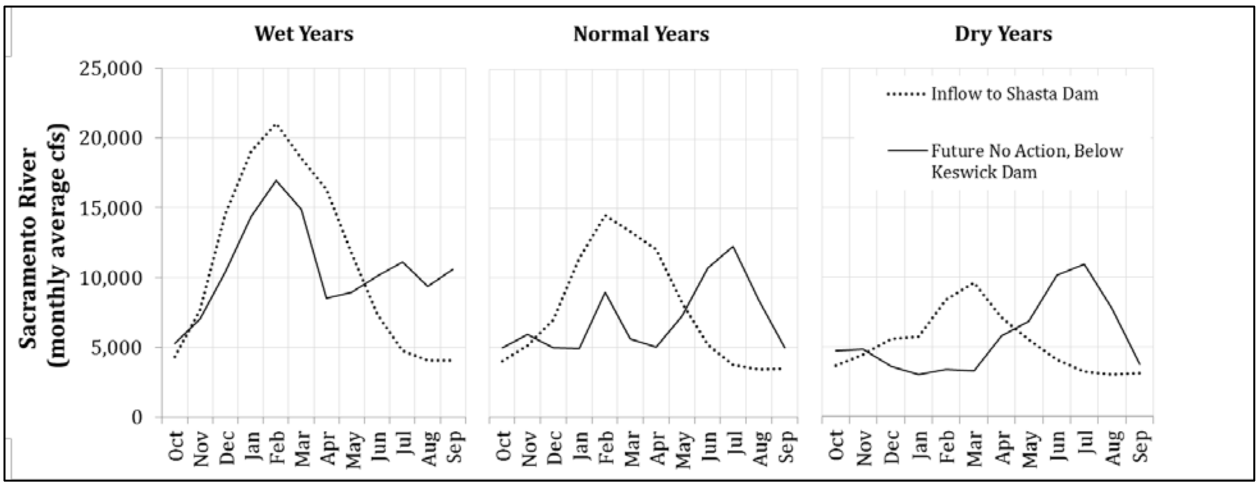
Impact Geo-7 (No-Action): Location on a Geologic Unit or Soil that Is Unstable, or that Would Become Unstable as a Result of the Project, and Potentially Result in Subsidence Under the No-Action Alternative, no new construction would occur and the full pool level would not be increased.

Therefore, there would be no increase in the risk of land subsidence. No impact would occur. Mitigation is not required for the No-Action Alternative.

Impact Geo-8 (No-Action): Failure of Septic Tanks or Alternative Wastewater Disposal Systems Due to Soils that Are Unsuited to Land Application of Waste Under the No-Action Alternative, no new construction would occur and the full pool level would not be increased. Therefore, there would be no increase in the risk of failure of septic tanks or alternative wastewater disposal systems. No impact would occur. Mitigation is not required for the No-Action Alternative.

Upper Sacramento River (Shasta Dam to Red Bluff) This section describes impacts on the upper Sacramento River portion of the primary study area.

Impact Geo-9 (No-Action): Substantial Increase in Channel Erosion and Meander Migration No Shasta Dam enlargement activities would be implemented, and no new water releases from the dam would occur as a result of the No-Action Alternative. As illustrated in Figure 4-9, inflow to Shasta Lake would continue to be released from Shasta and Keswick dams based on the operations for the Central Valley Project objectives and other project requirements.



Notes:
Wet Years comprised of water years (October – September) classified under State Water Board Decision 1641 as "Wet"
Normal Years comprised of years classified as "Above Normal" and "Below Normal"
Dry Years comprised of years classified as "Dry" or "Critical"

Figure 4-9. Comparison Between Inflow to Shasta Dam and No Action Alternative Releases at Keswick Dam

Figure 4-10 demonstrates how future operations of the baseline future conditions at Shasta Dam result in the capture of higher flows (generally months with inflows between 3- and 25-percent exceedence flow rates) for release during periods with more moderate inflows to Shasta Dam (generally months with inflows between 25- and 70-percent exceedence flow rates).

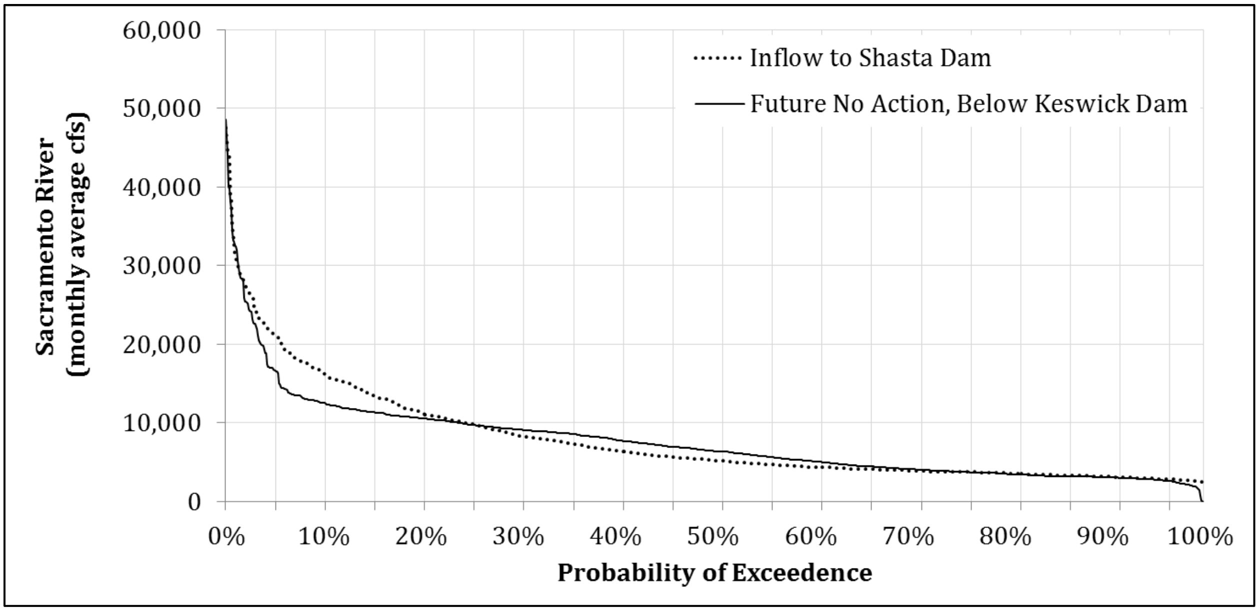


Figure 4-10. Percent Exceedence Comparison Between Inflow to Shasta Dam and Future No Action Alternative Releases from Keswick Dam

No changes would occur with implementation of the No-Action Alternative, therefore no impact would occur. Mitigation is not required for the No-Action Alternative.

Impact Geo-10 (No-Action): Substantial Soil Erosion or Loss of Topsoil Due to Construction No Shasta Dam enlargement activities would be implemented, and no gravel augmentation activities would occur as a result of the No-Action Alternative. Therefore, no soil additional soil erosion would be anticipated on the banks along the river channel. No impact would occur. Mitigation is not required for the No-Action Alternative.

Impact Geo-11 (No-Action): Alteration of Fluvial Geomorphology Under the No-Action Alternative, Shasta Dam operations would not change. Therefore, no changes in fluvial geomorphology would be anticipated. No impact would occur. Mitigation is not required for the No-Action Alternative.

Impact Geo-12 (No-Action): Alteration of Downstream Tributary Fluvial Geomorphology Due to Shasta Dam Operations Under the No-Action Alternative, Shasta Dam operations would not change. Therefore, no changes in the fluvial geomorphology of downstream tributaries would be anticipated. No impact would occur. Mitigation is not required for the No-Action Alternative.

Lower Sacramento River and Delta This section describes impacts on the lower Sacramento River and Delta portions of the extended study area associated with the No-Action Alternative.

Impact Geo-13 (No-Action): Substantial Increase in Channel Erosion and Meander Migration No Shasta Dam enlargement activities would be implemented, and no new water releases from the dam would occur as a result of the No-Action Alternative. The water releases from the dam would continue to vary based on time of year, water year types, and system conditions. Therefore, no impact would occur. Mitigation is not required for the No-Action Alternative.

CVP/SWP Service Areas This section describes the impacts associated with the No-Action Alternative on the CVP/SWP service areas within the extended study area.

Impact Geo-14 (No-Action): Substantial Increase in Channel Erosion and Meander Migration No Shasta Dam enlargement activities would be implemented, and no new water releases from the dam would occur as a result of the No-Action Alternative. No changes in operations would occur under the No-Action Alternative. The water releases from Shasta Dam, Folsom Dam, and Oroville Dam would continue to vary based on time of year, water year types, and system conditions, but would not be anticipated to be outside of normal operating conditions. Therefore, no impact would occur. Mitigation is not required for the No-Action Alternative.

CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

This section describes impacts associated with CP1, which focuses on increasing water supply reliability while contributing to increased anadromous fish survival by raising Shasta Dam 6.5 feet. The dam raise would increase the reservoir's full pool by 8.5 feet, and enlarge total storage space in the reservoir by 256,000 acre-feet. Section 2.3.8 in Chapter 2, "Alternatives," describes the construction activities and potential borrow sources associated with CP1.

Shasta Lake and Vicinity This section describes impacts on the Shasta Lake and vicinity portion of the primary study area.

Impact Geo-1 (CP1): Exposure of Structures and People to Geologic Hazards Resulting from Seismic Conditions, Slope Instability, and Volcanic Eruption Implementing CP1 has the potential to increase the exposure of structures and people to geologic hazards.

No active faults are known to be present within or immediately adjacent to the Shasta Lake and vicinity area, and there is a low risk of fault rupture (CDMG 2006a). According to LaForge and Hawkins (1986), Jennings (1994), and the California Department of Conservation, Division of Mines and Geology (1997), all known faults around the Shasta Lake and vicinity area are classified as inactive. (Inactive faults show no evidence of movement in the last 10,000 years (i.e., Holocene).) Because there are few active faults in close proximity to the Shasta Lake and vicinity area, the likelihood of strong seismic ground shaking also is low. Detailed, site-specific geologic and foundation investigations will be completed to develop design criteria to withstand reasonably probable seismic events. This impact would be less than significant for CP1. Mitigation for this impact is not needed, and thus not proposed.

Under CP1, the pool level increase would inundate 78 acres of mapped slope instability hazards (i.e., active and relict landslides, debris flows, inner gorge landscape positions, and complexes of these features). Relocation of infrastructure is proposed to occur within or adjacent to several relocation areas. Subsequent to the DEIS, these relocation areas were refined using updated engineering and resource information, thereby reducing the areas subject to slope instability hazards. Inundation of bedrock and soils resulting from the increased pool elevation, and earthwork and vegetation removal associated with new construction, could reduce the stability of hillslopes prone to mass wasting. The existing relict and active mass wasting features may become less stable. The risks associated with increased slope instability due to the rise in pool elevation and relocation of infrastructure have been considered in formulating the description of CP1. Areas of known instability have been addressed via avoidance or through design measures intended to minimize the risk of increased instability. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Hazards associated with volcanic eruptions have a low probability of occurring within the Shasta Lake and vicinity area. Significant impacts resulting from eruptions in the Medicine Lake Highlands and at Lassen Peak are unlikely due to their distance from Shasta Lake and the lack of drainage connections. Eruptions of Mount Shasta are not likely to deposit lithic ash, lava flows, domes, or pyroclastic flows within the reservoir, and Mount Shasta is not likely to erupt large volumes of pumiceous ash. The danger from floods caused by eruptions is similar to that from floods having other origins, and would be mitigated via the proposed dam modifications (e.g., increased spillway capacity) and operational procedures. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

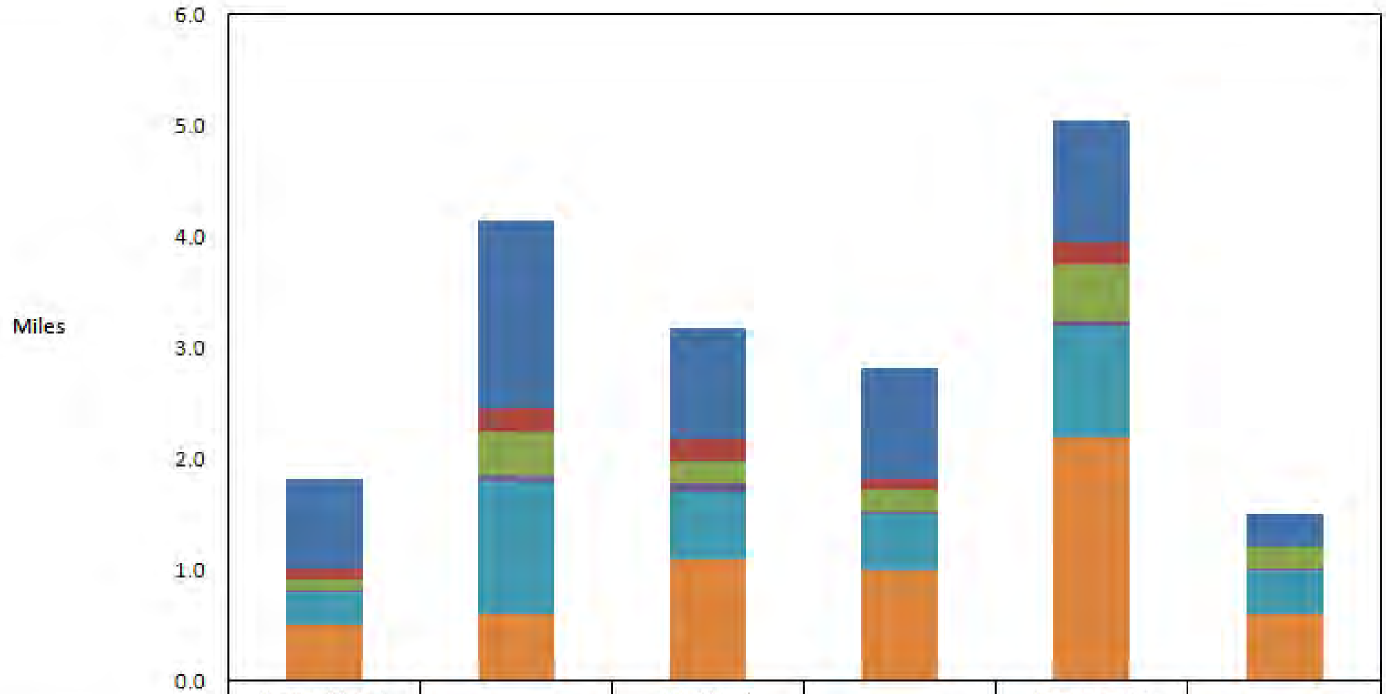
Similarly, the dangers from mudflows and seiche hazards are low, and would be mitigated via the proposed dam modifications (e.g., increased spillway capacity) and operational procedures. There are few seismic hazard areas within the Shasta Lake and vicinity area that would expose structures or people to geologic hazards. However, site-specific geologic and foundation investigations will be conducted to develop design criteria to withstand reasonably probable seismic events. In addition, areas of known instability around the perimeter of the lake shore have been addressed via avoidance or through design measures to minimize exposure of structures or people to slope instability. There is a low probability of hazards associated with volcanic eruptions within the Shasta Lake and vicinity area, but any potential for floods caused by eruptions is similar to that from floods having other origins and would be mitigated via the proposed dam modifications and operational procedures. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

There is the potential for Reservoir Triggered Seismicity (RTS), seismicity resulting from the impoundment of water at or near the Lake Shasta reservoir. However, proper seismic hazard analyses will be performed and the design earthquake will be correctly defined to mitigate for any potential hazards. RTS is characterized as: seismic events that are more frequent than background levels before impoundment; an increase in both frequency and magnitude of earthquake events resulting from large oscillations of storage levels; and triggered events that tend to decrease to background levels after peaking. To identify an RTS event, an appropriate local seismic network capable of recording microseismic events would be monitored and evaluated. By following the seismic design criteria, an impact resulting from RTS would be mitigated to less than significant. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Geo-2 (CP1): Alteration of Fluvial Geomorphology and Hydrology of Aquatic Habitats Under CP1, stream channel equilibrium and geomorphology would be affected by an increase in full pool level. Lower gradient channels (less than 10 percent slope) with existing delta deposits would be affected more than higher gradient channels. It is likely that the delta deposits would expand both upstream and downstream as a result of this alternative. When the lake is full and regional flooding occurs, sediment transported from the uplands would be deposited as deltas at the confluence of the streams and lake. When the lake level is low during base-flow periods, stream channels within the inundation zone are likely to be channelized as they downcut into the delta deposits. In the lower gradient channels, the stream type could shift to an unstable braided channel. This impact would be significant.

Inundation of lower gradient streams draining to Shasta Lake could result in long-term changes to channel equilibrium by changing the sediment transport capacity of the stream channels between 1,070 and 1,080 feet of elevation. CP1 could also destabilize the stream channels as a result of riparian vegetation loss on the lower and upper banks and a more mobile stream bed. Within the drawdown zone, the reintroduction of brush structures, large wood, and/or rock boulder clusters into a number of low-gradient perennial channels would provide some degree of structural complexity intended to improve habitat conditions for aquatic organisms.

Based on a stream network generated using Net Trace, the total stream length inundated as a result of CP1 is estimated to be 18.5 miles (see Figure 4-11), which equates to about 0.7 percent of the total length of the streams in watersheds that are directly adjacent and contributory to Shasta Lake. Of the 18.5 miles inundated, 716 stream segments totaling about 6.2 miles of streams with a gradient of less than 10 percent would be affected to some degree.



	Big Backbone Creek	Main Body	McCloud River	Pit River	Sacramento River	Squaw Creek
Intermittent >10% Grade	0.8	1.7	1.0	1.0	1.1	0.3
Perennial >10% Grade	0.1	0.2	0.2	0.1	0.2	0.0
Intermittent 7-10% Grade	0.1	0.4	0.2	0.2	0.5	0.2
Perennial 7-10% Grade	0.02	0.05	0.08	0.02	0.05	0.01
Intermittent <7% Grade	0.3	1.2	0.6	0.5	1.0	0.4
Perennial <7% Grade	0.5	0.6	1.1	1.0	2.2	0.6

Figure 4-11. Stream Lengths in Watersheds Adjacent to Shasta Lake that Would Be Periodically Inundated Under CP1

The increase in full pool would affect channels above the current full-pool elevation (1,070 msl) by altering their fluvial geomorphology and the hydrology of the aquatic habitats, as described above. This impact would be significant. Mitigation for this impact is proposed in Section 4.3.5.

Impact Geo-3 (CP1): Loss or Diminished Availability of Known Mineral Resources that Would Be of Future Value to the Region Significant quantities of cement, concrete sand and aggregate, and coarse aggregate would be needed under CP1. Cement Types I, II, III, and V are produced locally, but supplies are limited. Required quantities of concrete sand and aggregate are available from local commercial suppliers. The tonnage of sand anticipated to be needed is roughly more than 150 percent of the annual Shasta County production of sand and gravel. Embankment material (i.e., coarse aggregate) could be obtained from local sources, including from within Shasta Lake itself. Implementation of CP1 has the potential to diminish the availability of cement, and of concrete sand and aggregate, in the region. This impact would be significant. Mitigation for this impact is not proposed in Section 4.3.5 because no feasible mitigation is available to reduce the impact to a less-than-significant level.

Impact Geo-4 (CP1): Lost or Diminished Soil Biomass Productivity Under CP1, soil productivity would be lost due to periodic inundation caused by increasing the full pool elevation and by construction, including relocation of infrastructure. Using Equivalent FSSC as a surrogate metric for soil biomass productivity, implementation of CP1 would result in loss of the following acreages by productivity rank: moderate productivity – 1,954.6 acres; low productivity – 1,604.5 acres; nonproductive – 565 acres.

This impact would be significant. Mitigation for this impact is not proposed in Section 4.3.5 because no feasible mitigation is available to reduce the impact to a less-than-significant level.

Impact Geo-5 (CP1): Substantial Soil Erosion or Loss of Topsoil Due to Shoreline Processes Under CP1, the area of shoreline that would be periodically inundated would be about 1,229 acres. Substantial soil erosion and loss of topsoil would result. This impact would be significant.

The inundated area would be subjected to shoreline erosional processes. For the first 15 years after the dam raise, the average rate of shoreline erosion would increase substantially, from approximately 90 cubic yards per acre per year to about 300 cubic yards per acre per year. For the first time step (i.e., 15 years), the total average annual volume of potential shoreline erosion from CP1 would be about 421,000 cubic yards per year. Within 60 years of the dam raise, the average annual volume is predicted to decrease to approximately 107,000 cubic yards per year.

Sediment delivery from shoreline erosion would likely be greatest in the Sacramento Arm, the eastern portion of the Main Body of the lake, and the

McCloud Arm. These three arms are predicted to deliver more than 66,000 cubic yards per year for the first 15 years after the dam raise. Within 60 years of the dam raise, the average rate for these arms is predicted to decrease to about 19,000 cubic yards per year. The western portion of the Main Body of Shasta Lake and the Backbone Creek Arm are predicted to have the lowest shoreline erosion rates, resulting in a 15-year average annual potential erosion volume of less than 26,000 cubic yards per year. The Pit Arm is predicted to produce about 50,000 cubic yards per year and the Squaw Creek Arm about 35,000 cubic yards per year.

Assuming the available vegetation removal prescriptions between the 1,070-foot and 1,080-foot contours, for the first time step (i.e., 15 years after the raising of Shasta Dam), there would be about 421,000 cubic yards per year of shoreline erosion. After about 15–20 years, depending on climatic variability, the new shoreline would form and would start to stabilize. Total reservoir erosion is predicted to decrease by 70 percent between 15 and 60 years after the dam raise. The wetter the climate cycle, the more rapidly the shoreline is predicted to form and stabilize.

The analysis also calculated the 15-year erosion volume using the prescribed vegetation treatments and modeled higher erosion rates for shoreline with partial and complete vegetation removal. The Big Backbone, Squaw Creek, and Pit arms would have very little vegetation removal, which would not affect the short-term rate of shoreline erosion. The Main Body and the Sacramento and McCloud arms would have substantial amounts of vegetation removal, which would result in higher short-term erosion rates. For these arms, areas treated by vegetation removal represent about half of the total predicted erosion.

Soil erosion due to shoreline processes is estimated to be 421,000 cubic yards per year, assuming the available vegetation removal prescriptions between 1,070-foot and 1,080-foot contours would occur in the first 15 years after the raising of Shasta Dam. This impact would be significant. Mitigation for this impact is not proposed in Section 4.3.5 because no feasible mitigation is available to reduce the impact to a less-than-significant level.

Impact Geo-6 (CP1): Substantial Soil Erosion or Loss of Topsoil Due to Upland Processes Interpretations of soil susceptibility to erosion are presented in Table 4-12 for the portion of the area potentially disturbed by construction activities. The values in this table were updated based on refinement of the relocation areas after publication of the DEIS. Approximately 2,384 acres in the upland portion of the Shasta Lake and vicinity area could be disturbed; the likely area of disturbance is about 698 acres. The environmental commitments common to all action alternatives include implementation of best management practices, preparation and implementation of a SWPPP and development and implementation of site-specific revegetation plans. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

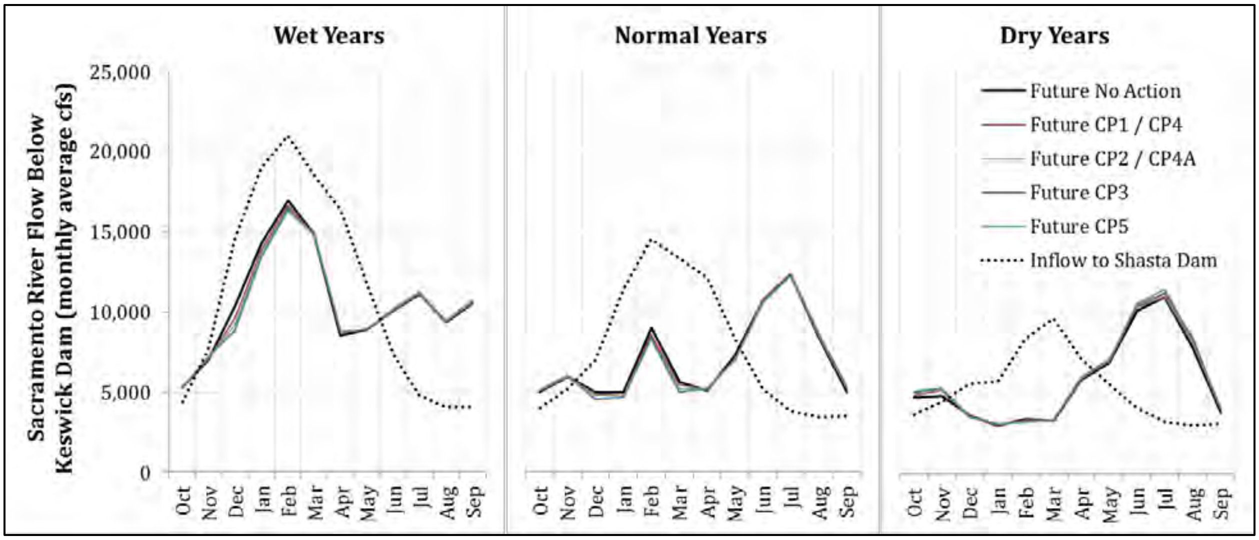
Construction-related erosion will be avoided and minimized via implementation of the SWPPP (i.e., erosion and sediment control plans, including site revegetation), which is part of the environmental commitments common to all action alternatives. These plans will address the necessary local jurisdiction requirements regarding erosion control and site revegetation, and would implement best management practices for erosion and sediment control. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Geo-7 (CP1): Location of Project Facilities on a Geologic Unit or Soil that Is Unstable or that Would Become Unstable as a Result of the Project, and Potentially Result in Subsidence Of the 2,384 acres of relocation areas within the Shasta Lake and vicinity area, a small proportion (about 5 percent) occupies landscape positions underlain by limestone; these areas would be avoided during relocation activities. Land subsidence has a potential to occur in areas underlain by certain limestones and in areas affected by underground construction. Detailed, site-specific geologic and foundation investigations will be completed to inform project design concerning ways to avoid potential subsidence from these causes. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Geo-8 (CP1): Failure of Septic Tanks or Alternative Wastewater Disposal Systems Due to Soils that Are Unsuited to Land Application of Waste In general, soils in the Shasta Lake and vicinity area are poorly suited to use as septic tank leach fields or for alternative waste disposal systems due to shallow soil depth, high rock content, and excessive slope. Relocated wastewater facilities would be designed and constructed to satisfy the conditions of the Shasta County Environmental Health Division Sewage Disposal System Permit. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Upper Sacramento River (Shasta Dam to Red Bluff) This section describes impacts on the upper Sacramento River portion of the primary study area associated with CP1.

Impact Geo-9 (CP1): Substantial Increase in Channel Erosion and Meander Migration This impact would be similar to Impact Geo-9 (No-Action). Additional storage at Lake Shasta, in comparison to the No-Action Alternative, allows for greater capture of high flows and additional releases during periods when the demand for water is high and inflows to Lake Shasta are relatively low. Figure 4-12 compares average monthly releases from Keswick Dam for all alternatives. Differences between releases for the No-Action and all action alternatives are not significant. These differences are most perceptible as reductions during the winters of Wet and Normal hydrologic conditions, and increases in summer of Dry hydrologic conditions. These differences are consistent with the inter-annual storage objectives of operations at Shasta Dam and facilities.



Notes:
Wet Years comprised of water years (Oct – Sep) classified under State Water Board Decision 1641 as “Wet”
Normal Years comprised of years classified as “Above Normal” and “Below Normal”
Dry Years comprised of years classified as “Dry” or “Critical”

Figure 4-12. Comparison Between Inflow to Shasta Dam and Future Alternative Releases from Keswick Dam

Alterations to river flows have the potential to alter downstream stream erosion and change downstream geomorphologic characteristics. Specifically, the characteristics of peak flows, including magnitude, duration, and the rate at which flows change (i.e., ramping rates), govern the mechanical processes on rivers such as erosion, scour, and deposition. Figure 4-13 demonstrates the changes in average monthly flows relative to the No-Action Alternative, which are most perceptible in exceedence range between 3- and 6-percent, which indicates the potential for reductions in low- to mid-range pulse flows. The releases from Keswick Dam shown in Figure 4-13 were simulated using a reservoir operations model that operates on a monthly time-step.

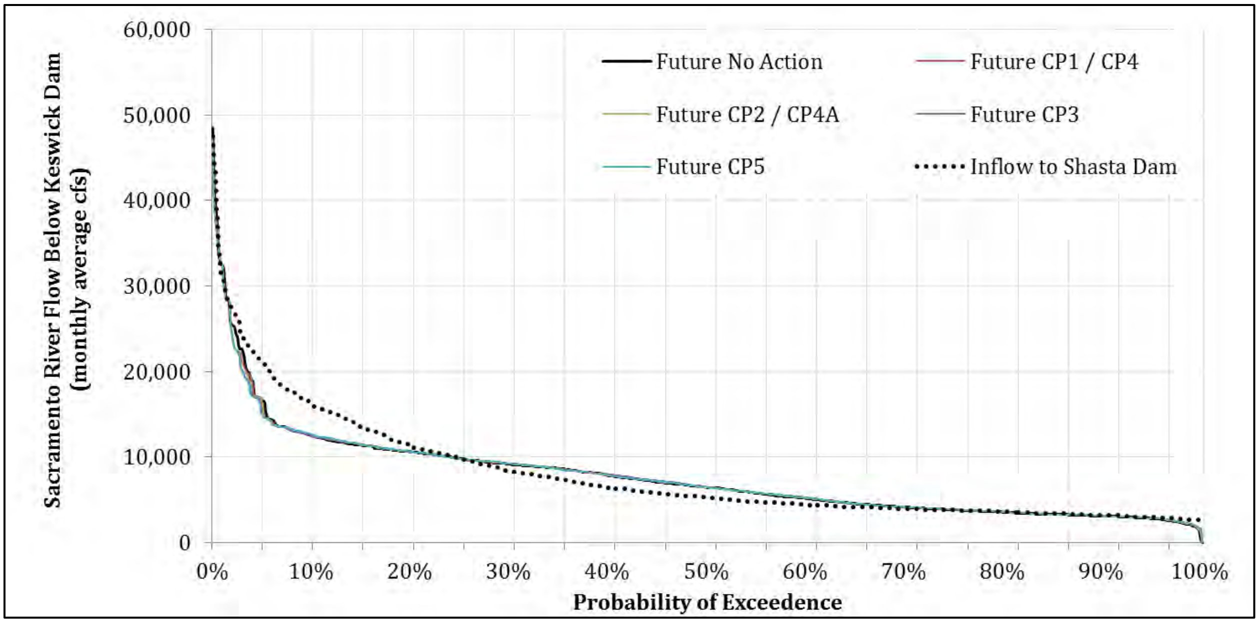


Figure 4-13. Percent Exceedence Comparison Between Inflow to Shasta Dam and Future Alternative Releases from Keswick Dam (monthly average cfs)

Geomorphic processes related to pulse flows are well correlated to daily hydrology, and only loosely correlated to monthly hydrology. Therefore, small differences in daily percent exceedence may or may not correspond to meaningful changes in geomorphology. A set of daily flows was extrapolated from the monthly model for use in temperature studies. A full description of this daily data set is described in Chapter 3, "Temporal Downsizing of CalSim-II Flows for Use in Temperature Modeling," in the EIS Modeling Appendix. This data set was used to construct daily exceedence plots, shown in Figures 4-14 and 4-15. Similar to the monthly exceedence plots, reductions in releases from Keswick Reservoir relative to the No-Action Alternative are most perceptible in exceedence range between 1- and 6-percent. These reductions are relatively small, only apply to small- to mid-sized pulse flows, and are unlikely to affect the geomorphology of the Sacramento River in a significant manner.

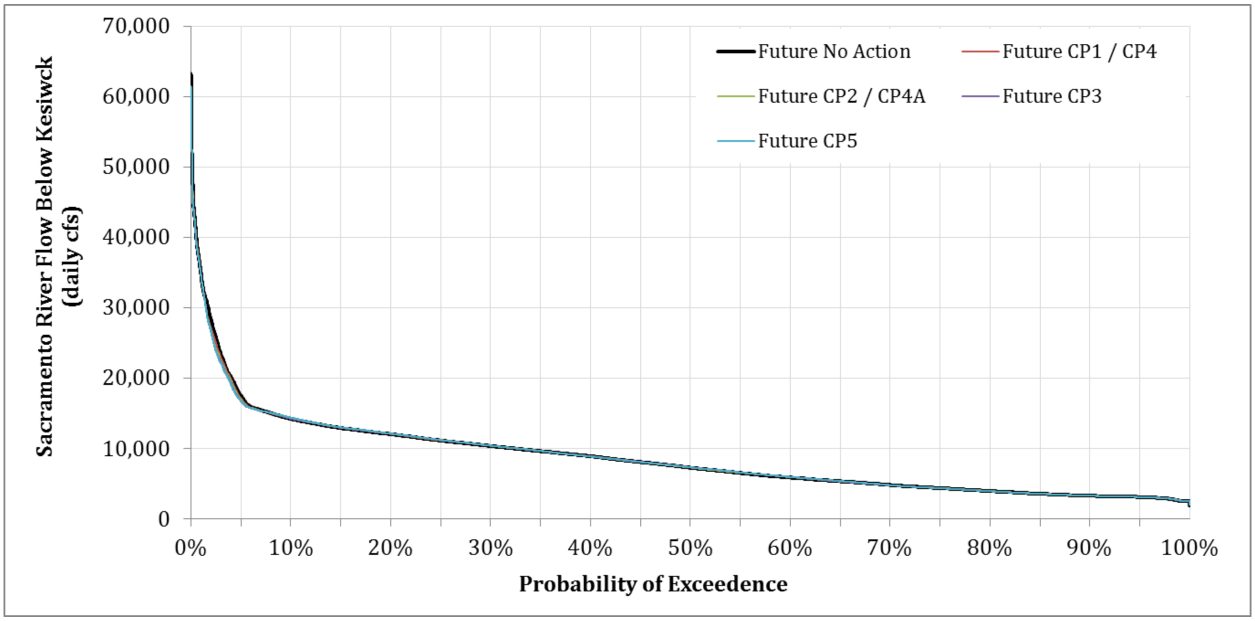


Figure 4-14. Percent Exceedence (0% to 100%) Comparison Between Future Alternative Releases from Keswick Dam (daily cfs)

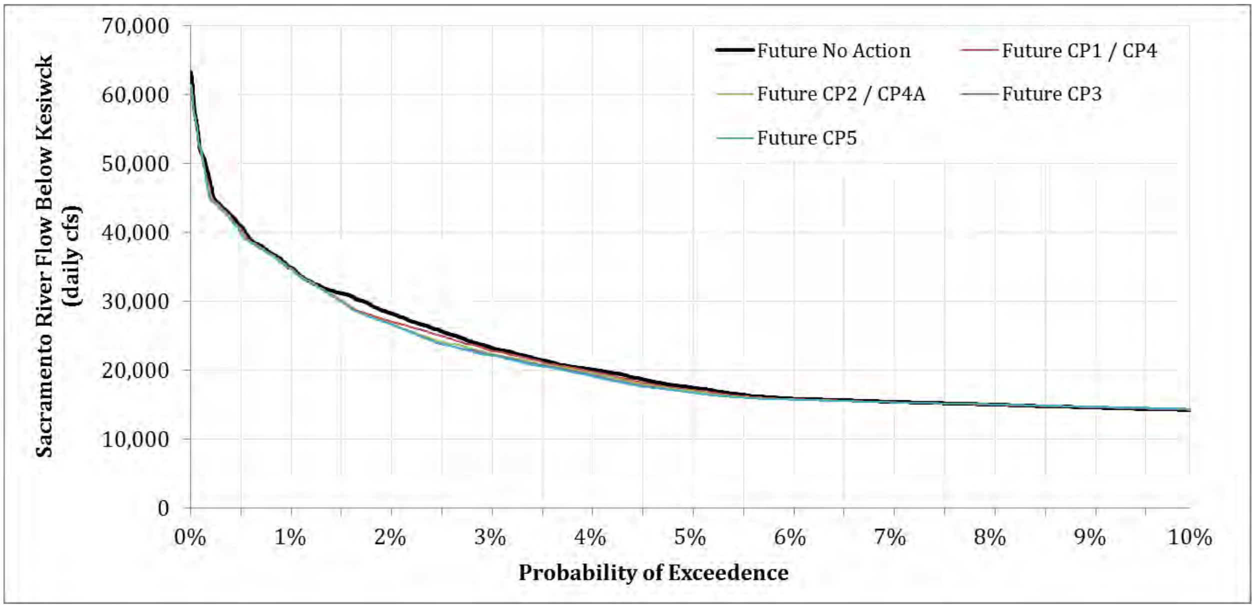


Figure 4-15. Percent Exceedence (0% to 10%) Comparison Between Future Alternative Releases from Keswick Dam (daily cfs)

The frequency and duration of high-flow events resulting from this action are expected to be reduced as compared to existing conditions with current operations. Therefore, downstream erosion is anticipated to decrease or remain stable. This impact would be less than significant.

Reductions of stream bedload contribution are greatest during high-flow events. Bed and bank conditions in streams and rivers are created, maintained, and destroyed by natural geomorphic processes whose rates and patterns are regulated through complex interactions of flow, sediment transport, and properties of the channel and floodplain (including slope, erodibility, and morphology). Because large fluvial systems, such as the Sacramento River and its floodplain, are affected by the interaction of a wide variety of geomorphic processes, quantifying and understanding how they evolve can be complex. The legacy of land and water use in a region adds to the complexity, modulating factors such as flow, sediment supply, and floodplain erodibility, thus affecting the dynamics of riverine and floodplain characteristics.

High-flow events can mobilize and scour gravel stored in the channel bed, routing the sediment downstream. In the alluvial reaches of unregulated rivers, the sediment scoured from a local reach is generally replaced by sediment transported from upstream, supplied from tributaries, or recruited from storage in riverbanks. There may be short-term or local changes in the amount of gravel stored in a channel bed due to episodic sediment delivery (e.g., mass wasting events in the watershed) or extreme flow events. However, over a broader time span, unregulated rivers generally achieve a balance between sediment supply and routing so that in-channel sediment storage is maintained.

The first significant natural source of sediment to the Sacramento River is nearly 30 miles (48 kilometers) downstream from Keswick Dam at Cottonwood Creek (River Mile 273.5). Tributaries between Keswick Dam and Cottonwood Creek contribute little sediment to the mainstem because they drain small basins of erosion-resistant material or, as is the case for Clear Creek, are themselves regulated by dams and are affected by aggregate mining. Much of the upper Sacramento River (i.e., from River Mile 302 to approximately River Mile 273.5) is bounded by erosion-resistant bedrock and terrace deposits, such that bank erosion is not fast enough, relative to in-channel transport, to provide a significant source of coarse sediment. In other words, the rate of supply from erosion of banks due to meander migration in the upper river is minimal.

Meander migration and bank erosion occur by two processes: progressive channel migration, in which flows erode banks incrementally, and episodic meander-bend cutoff, in which the channel avulses to a completely new course. Cutoffs may be partial or complete, depending on initial meander bend geometry and the resistance of bank and floodplain materials to erosion, among other factors. Complete cutoffs are often referred to as "chute cutoffs." Partial cutoffs are sometimes also referred to as "neck cutoffs" in geomorphology texts and literature. While progressive migration and episodic cutoff can generally be thought of as distinct (i.e., mutually exclusive) processes, they are nevertheless interrelated because they simultaneously regulate and are affected by sinuosity and other channel characteristics.

An erosion and sediment control plan would be implemented, as described in Section 2.3.2, "Environmental Commitments Common to All Action Alternatives," in Chapter 2, "Alternatives," to control any short-term and long-term erosion and sedimentation effects of construction activities. This impact would be less than significant. Mitigation for this impact is not needed. However, mitigation for this impact is proposed in Section 4.3.5 to further reduce the impact.

Impact Geo-10 (CP1): Substantial Soil Erosion or Loss of Topsoil Due to Construction With implementation of CP1, no gravel augmentation activities or construction activities would occur at potential upper Sacramento River restoration sites. Therefore, no additional soil erosion would be anticipated on the banks along the river channel. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact Geo-11 (CP1): Alteration of Fluvial Geomorphology With implementation of CP1, no potential upper Sacramento River restoration activities would occur. Therefore, no changes in fluvial geomorphology would be anticipated. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact Geo-12 (CP1): Alteration of Downstream Tributary Fluvial Geomorphology Due to Shasta Dam Operations Under CP1, the fluvial geomorphology of downstream tributaries would not be affected by changes in Sacramento River stage attributed to Shasta Dam operations. Small increases in Sacramento River stage may occur with implementation of CP1. However, the frequency and duration of high-flow events resulting from CP1 implementation are expected to be reduced as compared to existing conditions with current operations. This impact would be less than significant.

Where they occur, geomorphic changes (headcutting, channel incisement, etc.) in major tributaries in Cow, Clear and Cottonwood creeks has been directly attributed to the presence of dams (on Clear Creek) and past and current instream gravel mining on the tributaries themselves. Future operations at Shasta Dam under CP1 are not anticipated to result in significant geomorphic changes at these major tributaries in comparison to the No-Action Alternative. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta This section describes impacts on the lower Sacramento River and Delta portions of the extended study area associated with CP1.

Impact Geo-13 (CP1): Substantial Increase in Channel Erosion and Meander Migration It is not anticipated that implementation of CP1 would lead to increased channel erosion and meander migration as compared to the No-Action Alternative and existing conditions. With implementation of CP1, there would be a potential reduction in high-flow events. Therefore, increases in Sacramento River flow would be limited and effects on reservoirs and rivers in the extended study area would be attenuated and dissipated by the large number of these water bodies, as well as flood bypasses in the extended study area. This impact would be less than significant.

This impact would be very similar to Impact Geo-9 (CP1), but would take place in the lower Sacramento River and Delta where the effects of increases in Sacramento River flow would be limited and effects on reservoirs and rivers would be attenuated and dissipated. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CVP/SWP Service Areas This section describes impacts on the CVP/SWP service areas within the extended study area associated with CP1.

Impact Geo-14 (CP1): Substantial Increase in Channel Erosion and Meander Migration It is not anticipated that implementation of CP1 would lead to increased channel erosion and meander migration as compared to the No-Action Alternative and existing conditions. Changes in water operations in the CVP/SWP service areas could potentially result in small changes in flow in the American and Feather rivers, as a result of operations at Folsom Dam and Oroville Dam. However, changes in flow affecting these reservoirs and rivers in the extended study area would be within the normal range of conditions and would not be expected to result in an increase in channel erosion or meander migration. This impact would be less than significant.

This impact would be very similar to Impact Geo-9 (CP1), but would be associated with the CVP/SWP service areas that extend along the Sacramento River. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

This section describes impacts associated with CP2, which focuses on enlarging Shasta Dam and Reservoir by raising Shasta Dam 12.5 feet. The dam raise would increase the reservoir's full pool by 14.5 feet, and enlarge total storage space in the reservoir by 443,000 acre-feet. Section 2.3.8 in Chapter 2, "Alternatives," describes the construction activities and potential borrow sources associated with CP2.

Shasta Lake and Vicinity This section describes impacts on the Shasta Lake portion of the primary study area.

Impact Geo-1 (CP2): Exposure of Structures and People to Geologic Hazards Resulting from Seismic Conditions, Slope Instability, and Volcanic Eruption Implementing CP2 has the potential to increase the exposure of structures and people to geologic hazards similar to CP1. For the same reasons as apply to

CP1, impacts resulting from seismic conditions would be less than significant for CP2.

Under CP2, the pool level increase would inundate 110 acres of mapped slope instability hazards. Relocation of infrastructure under CP2 would occur in the vicinity of mapped slope instability hazards to a similar but greater extent than under CP1 (up to about 232 acres). For the same reasons as apply to CP1, impacts resulting from slope instability hazards would be less than significant for CP2.

For the same reasons as apply to CP1, impacts resulting from hazards associated with volcanic eruptions would be less than significant for CP2.

No active faults are known to be present within or immediately adjacent to the Shasta Lake and vicinity area, and there is a low risk of fault rupture (CDMG 2006a). According to LaForge and Hawkins (1986), Jennings (1994), and the California Department of Conservation, Division of Mines and Geology (1997), all known faults around the Shasta Lake and vicinity area are classified as inactive. (Inactive faults show no evidence of movement in the last 10,000 years (i.e., Holocene).) Because there are few active faults in close proximity to the Shasta Lake and vicinity area, the likelihood of strong seismic ground shaking also is low. Detailed, site-specific geologic and foundation investigations will be completed to develop design criteria to withstand reasonably probable seismic events. This impact would be less than significant for CP2. Mitigation for this impact is not needed, and thus not proposed.

There is the potential for Reservoir Triggered Seismicity (RTS), seismicity resulting from the impoundment of water at or near the Lake Shasta reservoir. However, proper seismic hazard analyses will be performed and the design earthquake will be correctly defined to mitigate for any potential hazards. RTS is characterized as: seismic events that are more frequent than background levels before impoundment; an increase in both frequency and magnitude of earthquake events resulting from large oscillations of storage levels; and triggered events that tend to decrease to background levels after peaking. To identify an RTS event, an appropriate local seismic network capable of recording microseismic events would be monitored and evaluated. By following the seismic design criteria, an impact resulting from RTS would be mitigated to less than significant. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

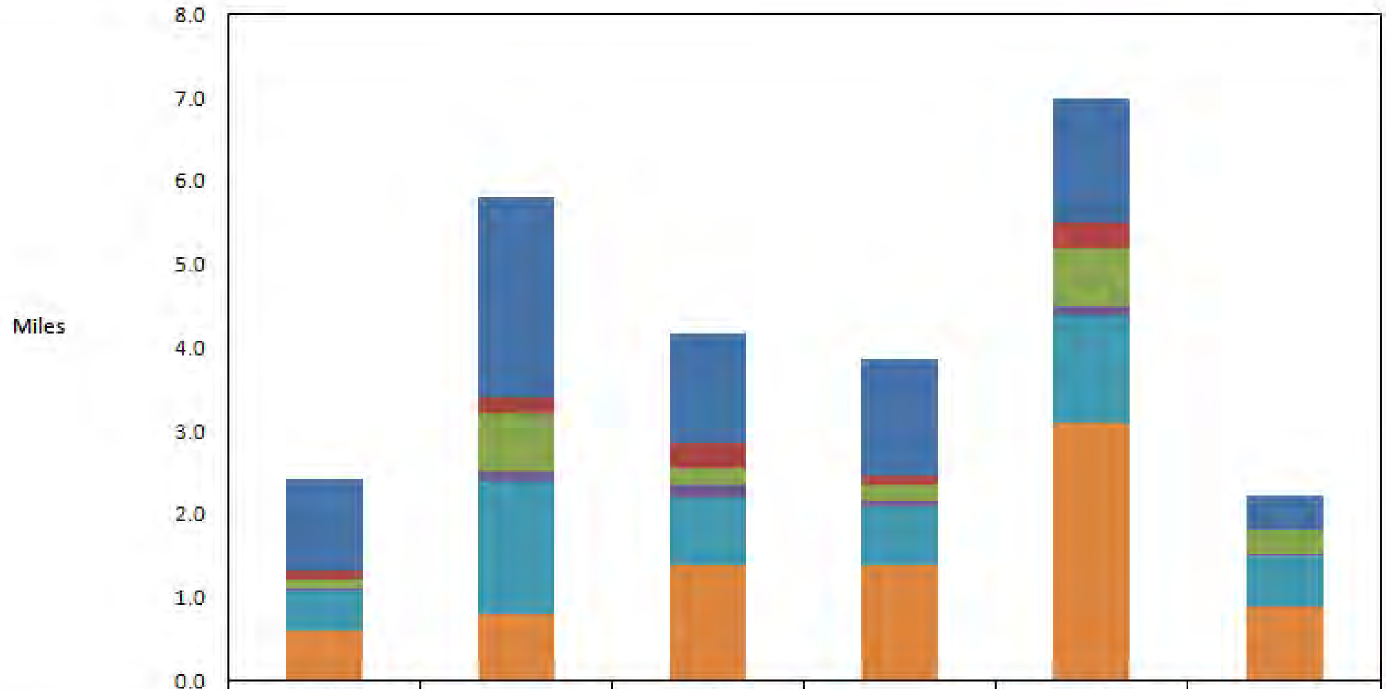
Impact Geo-2 (CP2): Alteration of Fluvial Geomorphology and Hydrology of Aquatic Habitats Like CP1, under CP2 stream channel equilibrium and geomorphology would be affected by an increase in full pool level. Inundation of lower gradient streams draining to Shasta Lake could result in long-term changes to channel equilibrium by changing the sediment transport capacity of the stream channels between 1,070 and 1,084 feet of elevation. This impact would be significant.

Based on a stream network generated using Net Trace, the total stream length inundated as a result of CP2 would be 25.5 miles (see Figure 4-16), which equates to about 0.9 percent of the total length of the streams in watersheds that are directly adjacent and contributory to Shasta Lake. Of the 25.5 miles inundated, 716 stream segments totaling about 8.2 miles of streams with a gradient less than 10 percent would be affected to some degree.

Within the drawdown zone, there would be some benefit to channels with implementation of the environmental commitment to introduce brush structures, large wood, and/or boulder/rock clusters at various locations within low gradient reaches of perennial channels.

The increase in full pool would affect channels by altering fluvial geomorphology and the hydrology of aquatic habitats as described above. This impact would be significant. Mitigation for this impact is proposed in Section 4.3.5.

Impact Geo-3 (CP2): Loss or Diminished Availability of Known Mineral Resources that Would Be of Future Value to the Region Implementing CP2 has the same potential as CP1 to diminish the availability in the region of cement, and of concrete sand and aggregate. For the same reasons as apply to CP1, this impact would be significant. Mitigation for this impact is not proposed in Section 4.3.5 because no feasible mitigation is available to reduce the impact to a less-than-significant level.



	Big Backbone Creek	Main Body	McCloud River	Pit River	Sacramento River	Squaw Creek
Intermittent >10% Grade	1.1	2.4	1.3	1.4	1.5	0.4
Perennial >10% Grade	0.1	0.2	0.3	0.1	0.3	0.0
Intermittent 7-10% Grade	0.1	0.7	0.2	0.2	0.7	0.3
Perennial 7-10% Grade	0.02	0.1	0.16	0.06	0.1	0.02
Intermittent <7% Grade	0.5	1.6	0.8	0.7	1.3	0.6
Perennial <7% Grade	0.6	0.8	1.4	1.4	3.1	0.9

Figure 4-16. Stream Lengths in Watersheds Adjacent to Shasta Lake that Would Be Periodically Inundated Under CP2

Impact Geo-4 (CP2): Lost or Diminished Soil Biomass Productivity Like CP1, under CP2 soil productivity would be lost due to periodic inundation caused by increasing the full pool elevation and by construction, including relocation of infrastructure. Using Equivalent FSSC as a surrogate metric for soil biomass productivity, implementation of CP2 would result in loss of the following acreages by productivity rank: moderate productivity – 2,128 acres; low productivity – 1,751 acres; nonproductive – 638 acres.

This impact would be significant. Mitigation for this impact is not proposed in Section 4.3.5 because no feasible mitigation is available to reduce the impact to a less-than-significant level.

Impact Geo-5 (CP2): Substantial Soil Erosion or Loss of Topsoil Due to Shoreline Processes Under CP2, the area of shoreline that would be inundated would be about 1,734 acres. Substantial soil erosion and loss of topsoil would result. This impact would be significant.

For the first 15 years after the dam raise, the average rate of shoreline erosion would increase substantially, from 90 cubic yards per acre per year to about 300 cubic yards per acre per year. For the first time step (i.e., 15 years), the total average annual volume of potential shoreline erosion from CP2 would be about 549,000 cubic yards per year. Within 60 years of the dam raise, the average annual volume is predicted to decrease to 150,000 cubic yards per year.

Sediment delivery from shoreline erosion would likely be greatest in the Sacramento Arm, the eastern portion of the Main Body of the lake, and the McCloud Arm. These three arms are predicted to deliver more than 90,000 cubic yards per year for the first 15 years after the dam raise. Within 60 years of the dam raise, the average rate for these arms is predicted to decrease to 27,000 cubic yards per year. The western portion of the Main Body and the Backbone Creek Arm are predicted to have the lowest shoreline erosion rates, a 15-year average annual potential erosion volume of less than 43,000 cubic yards per year. The Pit Arm is predicted to produce about 67,000 cubic yards per year and the Squaw Creek Arm about 63,000 cubic yards per year.

Assuming the available vegetation removal prescriptions between the 1,070-foot and 1,084-foot contours, for the first time step (i.e., 15 years after the raising of Shasta Dam), there would be about 549,000 cubic yards per year of shoreline erosion. After about 15–20 years, depending on climatic variability, the new shoreline would form and would start to stabilize. Total reservoir erosion is predicted to decrease by 70 percent between 15 and 60 years after the dam raise. The wetter the climate cycle, the more rapidly the shoreline is predicted to form.

The analysis also calculated the 15-year erosion volume using the prescribed vegetation treatments and modeled higher erosion rates for shoreline with partial and complete vegetation removal. The Big Backbone, Squaw Creek, and

Pit arms would have very little vegetation removal, which would not affect the short-term rate of shoreline erosion. The Main Body of Shasta Lake and the Sacramento River and McCloud arms would have substantial amounts of vegetation removal, which would result in higher short-term erosion rates. For these arms, areas treated by vegetation removal represent about half of the total predicted erosion.

This impact would be significant. Mitigation for this impact is not proposed in Section 4.3.5 because no feasible mitigation is available to reduce the impact to a less-than-significant level.

Impact Geo-6 (CP2): Substantial Soil Erosion or Loss of Topsoil Due to Upland Processes CP2 is similar to CP1 with respect to its potential to cause substantial soil erosion or loss of topsoil due to upland processes. Interpretations of soil susceptibility to erosion are presented in Table 4-12 for the portion of the area that potentially would be disturbed by construction activities. The values in this table were updated based on refinement of the relocation areas after publication of the DEIS. Approximately 2,384 acres in the upland portion of the Shasta Lake and vicinity area could be disturbed, but the likely area of disturbance is about 698 acres. The environmental commitments common to all action alternatives include implementation of best management practices, preparation and implementation of a SWPPP, and development and implementation of site-specific revegetation plans. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Construction-related erosion will be avoided and minimized via implementation of the SWPPP (i.e., erosion and sediment control plans, including site revegetation) that is a part of the environmental commitments common to all action alternatives. These plans will address the local requirements regarding erosion control and site revegetation, and would implement best management practices for erosion and sediment control. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Geo-7 (CP2): Location of Project Facilities on a Geologic Unit or Soil that Is Unstable, or that Would Become Unstable as a Result of the Project, and Potentially Result in Subsidence CP2 is similar to CP1 with respect to its potential to cause or be affected by subsidence. For the same reasons as apply to CP1, this impact would be less than significant for CP2, because detailed, site-specific geologic and foundation investigations will be completed to inform project design as to how to avoid potential subsidence from these causes. Mitigation for this impact is not needed, and thus not proposed.

Impact Geo-8 (CP2): Failure of Septic Tanks or Alternative Wastewater Disposal Systems Due to Soils that are Unsuited to Land Application of Waste CP2 is similar to CP1 with respect to its potential to cause or be affected by failure of septic tanks or alternative wastewater disposal systems due to soils that are unsuited to land application of waste. For the same reasons as apply to

CP1, this impact would be less than significant for CP2 because relocated wastewater facilities would be designed and constructed to satisfy the conditions of the Shasta County Environmental Health Division Sewage Disposal System Permit. Mitigation for this impact is not needed, and thus not proposed.

Upper Sacramento River (Shasta Dam to Red Bluff) This section describes the impacts on the upper Sacramento River portion of the primary study area associated with CP2.

Impact Geo-9 (CP2): Substantial Increase in Channel Erosion and Meander Migration It is not anticipated that implementation of CP2 would lead to increased channel erosion and meander migration as compared to the No-Action Alternative and existing conditions. However, by altering storage and operations at Shasta Lake as compared to the No-Action Alternative and existing conditions, this alternative would change the maximum pool elevation and seasonal pool elevations at Shasta Lake and the flow regime in the Sacramento River and potentially several other reservoirs and downstream waterways. Alterations to river flows have the potential to alter downstream stream erosion and change downstream geomorphologic characteristics. However, the frequency and duration of high-flow events resulting from this action are expected to be reduced as compared to existing conditions with current operations. Therefore, downstream erosion would not be anticipated to increase. An erosion and sediment control plan would be implemented, as described in Section 2.3.2, “Environmental Commitments Common to All Action Alternatives,” in Chapter 2, “Alternatives,” to control any short-term and long-term erosion and sedimentation effects of construction activities. This impact would be less than significant.

This impact would be very similar to Impact Geo-9 (CP1), except the modification of flow regimes would be slightly greater under CP2. This impact would be less than significant. Mitigation for this impact is not needed. However, mitigation for this impact is proposed in Section 4.3.5 to further reduce the impact.

Impact Geo-10 (CP2): Substantial Soil Erosion or Loss of Topsoil Due to Construction With implementation of CP2, no gravel augmentation activities would occur. Therefore, no soil additional soil erosion would be anticipated on the banks along the river channel. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact Geo-11 (CP2): Alteration of Fluvial Geomorphology With implementation of CP2, no potential upper Sacramento River restoration activities would occur. Therefore, no changes in fluvial geomorphology would be anticipated. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact Geo-12 (CP2): Alteration of Downstream Tributary Fluvial Geomorphology Due to Shasta Dam Operations Under CP2, the fluvial geomorphology of downstream tributaries would not be affected by changes in Sacramento River stage attributed to Shasta Dam operations. Small increases in Sacramento River stage may occur with implementation of CP2. However, the frequency and duration of high-flow events resulting from CP2 implementation are expected to be reduced as compared to existing conditions with current operations.

Where they occur, geomorphic changes (headcutting, channel incisement, etc.) in major tributaries in Cow, Clear and Cottonwood creeks has been directly attributed to the presence of dams (on Clear Creek) and past and current instream gravel mining on the tributaries themselves. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta This section describes impacts on the lower Sacramento River and Delta portions of the extended study area associated with CP2.

Impact Geo-13 (CP2): Substantial Increase in Channel Erosion and Meander Migration It is not anticipated that implementation of CP2 would lead to increased channel erosion and meander migration as compared to the No-Action Alternative and existing conditions. With implementation of CP2, there would be a potential reduction in high-flow events. Therefore, increases in Sacramento River flow would be limited and effects on reservoirs and rivers in the extended study area would be attenuated and dissipated by the large number of these water bodies, as well as by flood bypasses in the extended study area. This impact would be less than significant.

This impact would be very similar to Impact Geo-9 (CP1), except the modification of flow regimes would be slightly greater under CP2. However, the effects of increases in Sacramento River flow in the extended study area would be limited and effects on reservoirs and rivers would be attenuated and dissipated. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CVP/SWP Service Areas This section describes impacts on the CVP/SWP service areas within the extended study area associated with CP2.

Impact Geo-14 (CP2): Substantial Increase in Channel Erosion and Meander Migration It is not anticipated that implementation of CP2 would lead to increased channel erosion and meander migration as compared to the No-Action Alternative and existing conditions. Changes in water operations in the CVP/SWP service areas could potentially result in small changes in flow in the American and Feather rivers, as a result of operations at Folsom Dam and Oroville Dam. However, changes in flow affecting these reservoirs and rivers in the extended study area would be within the normal range of conditions and would not be expected to result in an increase in channel erosion or meander migration. This impact would be less than significant.

This impact would be very similar to Impact Geo-9 (CP1), except the modification of flow regimes would be slightly greater under CP2. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CP3 – 18.5-Foot Dam Raise, Agricultural Water Supply Reliability and Anadromous Fish Survival

This section describes impacts associated with CP3, which focuses on the greatest practical enlargement of Shasta Dam and Reservoir consistent with the goals of the 2000 CALFED Bay-Delta Program Programmatic Record of Decision (CALFED 2000b). CP3 was formulated for the primary purposes of increased agricultural water supply reliability and increased anadromous fish survival by raising Shasta Dam 18.5 feet. The dam raise would raise the reservoir's full pool by 20.5 feet, and enlarge total storage space in the reservoir by 634,000 acre-feet. Section 2.3.8 in Chapter 2, "Alternatives," describes the construction activities and potential borrow sources associated with CP3.

Shasta Lake and Vicinity This section describes impacts on the Shasta Lake portion of the primary study area for CP3.

Impact Geo-1 (CP3): Exposure of Structures and People to Geologic Hazards Resulting from Seismic Conditions, Slope Instability, and Volcanic Eruption Implementing CP3 has the potential to increase the exposure of structures and people to geologic hazards similar to CP1. For the same reasons as apply to CP1, impacts resulting from seismic conditions would be less than significant for CP3.

Under CP3, the pool level increase would inundate 173 acres of mapped slope instability hazards (i.e., active and relict landslides, debris slides, and inner gorge landscape positions). Relocation of infrastructure under CP3 would occur in the vicinity of mapped slope instability hazards to a similar but greater extent than under CP2 (up to about 232 acres). For the same reasons as apply to CP1, impacts resulting from slope instability hazards would be less than significant for CP3.

For the same reasons as apply to CP1, impacts resulting from hazards associated with volcanic eruptions would be less than significant for CP3.

No active faults are known to be present within or immediately adjacent to the Shasta Lake and vicinity area, and there is a low risk of fault rupture (CDMG 2006a). According to LaForge and Hawkins (1986), Jennings (1994), and the California Department of Conservation, Division of Mines and Geology (1997), all known faults around the Shasta Lake and vicinity area are classified as inactive. (Inactive faults show no evidence of movement in the last 10,000 years (i.e., Holocene).) Because there are few active faults in close proximity to the Shasta Lake and vicinity area, the likelihood of strong seismic ground shaking also is low. Detailed, site-specific geologic and foundation investigations will be completed to develop design criteria to withstand reasonably probable seismic events. This impact would be less than significant for CP3. Mitigation for this impact is not needed, and thus not proposed.

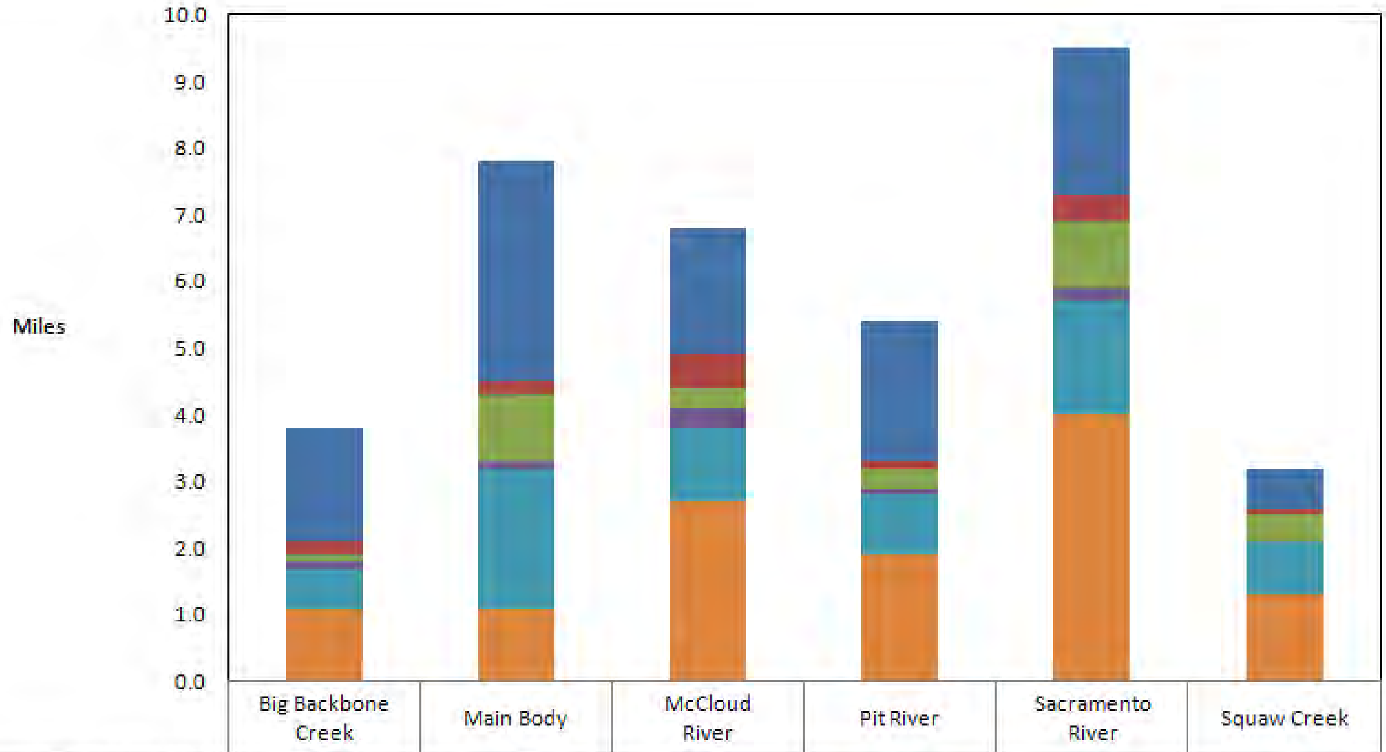
There is the potential for Reservoir Triggered Seismicity (RTS), seismicity resulting from the impoundment of water at or near the Lake Shasta reservoir. However, proper seismic hazard analyses will be performed and the design earthquake will be correctly defined to mitigate for any potential hazards. RTS is characterized as: seismic events that are more frequent than background levels before impoundment; an increase in both frequency and magnitude of earthquake events resulting from large oscillations of storage levels; and triggered events that tend to decrease to background levels after peaking. To identify an RTS event, an appropriate local seismic network capable of recording microseismic events would be monitored and evaluated. By following the seismic design criteria, an impact resulting from RTS would be mitigated to less than significant. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Geo-2 (CP3): Alteration of Fluvial Geomorphology and Hydrology of Aquatic Habitats Similar to CP1, under CP3 stream channel equilibrium and geomorphology would be affected by an increase in full pool level. Inundation of lower gradient streams draining to Shasta Lake could result in long-term changes to channel equilibrium by changing the sediment transport capacity of the stream channels between 1,070 and 1,090 feet of elevation. This impact would be significant.

Based on a GIS-generated stream network, the total stream length inundated as a result of CP3 would be 36.5 miles (see Figure 4-17), which equates to about 1.3 percent of the total length of the streams in watersheds that are directly adjacent and contributory to Shasta Lake. Of the 36.5 miles inundated, 716 stream segments totaling about 12.1 miles of streams with a gradient less than 10 percent would be affected to some degree.

Within the drawdown zone, there would be some benefit to channels with implementation of the environmental commitment to introduce brush structures, large wood, and/or boulder/rock clusters at various locations within low gradient reaches of perennial channels.

The increase in full pool would affect streams by altering fluvial geomorphology and the hydrology of aquatic habitats as described above. This impact would be significant. Mitigation for this impact is proposed in Section 4.3.5.



	Big Backbone Creek	Main Body	McCloud River	Pit River	Sacramento River	Squaw Creek
Intermittent >10% Grade	1.7	3.3	1.9	2.1	2.2	0.6
Perennial >10% Grade	0.2	0.2	0.5	0.1	0.4	0.1
Intermittent 7-10% Grade	0.1	1.0	0.3	0.3	1.0	0.4
Perennial 7-10% Grade	0.1	0.1	0.3	0.1	0.2	0.0
Intermittent <7% Grade	0.6	2.1	1.1	0.9	1.7	0.8
Perennial <7% Grade	1.1	1.1	2.7	1.9	4.0	1.3

Figure 4-17. Stream Lengths in Watersheds Adjacent to Shasta Lake that Would Be Periodically Inundated Under CP3, CP4, CP4A, and CP5

Impact Geo-3 (CP3): Loss or Diminished Availability of Known Mineral Resources that Would Be of Future Value to the Region Implementing CP3 has the same potential as CP1 to diminish the availability in the region of cement, and of concrete sand and aggregate. For the same reasons as apply to CP1, this impact would be significant. Mitigation for this impact is not proposed in Section 4.3.5 because no feasible mitigation is available to reduce the impact to a less-than-significant level.

Impact Geo-4 (CP3): Loss or Diminished Soil Biomass Productivity Like CP1, under CP3 soil productivity would be lost due to periodic inundation caused by increasing the full pool elevation and by construction, including relocation of infrastructure. Using Equivalent FSSC as a surrogate metric for soil biomass productivity, implementation of CP3 would result in loss of the following acreages by productivity rank: moderate productivity – 2,301 acres; low productivity – 2,092 acres; nonproductive – 760 acres.

This impact would be significant. Mitigation for this impact is not proposed in Section 4.3.5 because no feasible mitigation is available to reduce the impact to a less-than-significant level.

Impact Geo-5 (CP3): Substantial Soil Erosion or Loss of Topsoil Due to Shoreline Processes Under CP3, the area of shoreline that would be inundated would be about 2,498 acres. Substantial soil erosion and loss of topsoil would result. This impact would be significant.

For the first 15 years after the dam raise, the average rate of shoreline erosion would increase substantially, from 90 cubic yards per acre per year to about 300 cubic yards per acre per year. For the first time step (i.e., 15 years), the total average annual volume of potential shoreline erosion from CP3 would be about 767,000 cubic yards per year. Within 60 years of the dam raise, the average annual volume is predicted to decrease to 216,000 cubic yards per year.

Sediment delivery from shoreline erosion would likely be greatest in the Sacramento Arm, the eastern portion of the Main Body of the lake, and the McCloud Arm. These three arms are predicted to deliver more than 140,000 cubic yards per year for the first 15 years after the dam raise. Within 60 years of the dam raise, the average rate for these arms is predicted to decrease to 39,000 cubic yards per year. The western portion of the Main Body and the Backbone Creek Arm are predicted to have the lowest shoreline erosion rates, a 15-year average annual potential erosion volume of less than 57,000 cubic yards per year. The Pit Arm is predicted to produce about 99,000 cubic yards per year and the Squaw Creek Arm about 68,000 cubic yards per year.

Assuming the available vegetation removal prescriptions between the 1,070-foot and 1,090-foot contours, for the first time step (i.e., 15 years after the raising of Shasta Dam), there would be about 767,000 cubic yards per year of shoreline erosion. After about 15–20 years, depending on climatic variability, the new shoreline would form and would start to stabilize. Total reservoir erosion is predicted to decrease by 70 percent between 15 and 60 years after the dam raise. The wetter the climate cycle, the more rapidly the shoreline is predicted to form.

The analysis also calculated the 15-year erosion volume using the prescribed vegetation treatments and modeled higher erosion rates for shoreline with partial and complete vegetation removal. The Big Backbone, Squaw Creek, and Pit arms would have very little vegetation removal, which would not affect the short-term rate of shoreline erosion. The Main Body and the Sacramento and McCloud arms would have substantial amounts of vegetation removal, which would result in higher short-term erosion rates. For these arms, areas treated by vegetation removal represent about half of the total predicted erosion.

Soil erosion due to shoreline processes is estimated to be 767,000 cubic yards per year, assuming the available vegetation removal prescriptions between 1,070-foot and 1,090-foot contours would occur in the first 15 years after the raising of Shasta Dam. This impact would be significant. Mitigation for this impact is not proposed in Section 4.3.5 because no feasible mitigation is available to reduce the impact to a less-than-significant level.

Impact Geo-6 (CP3): Substantial Soil Erosion or Loss of Topsoil Due to Upland Processes CP3 is similar to CP1 with respect to its potential to cause substantial soil erosion or loss of topsoil due to upland processes.

Interpretations of soil susceptibility to erosion are presented in Table 4-12 for the portion of the area that potentially would be disturbed by construction activities. The values in this table were updated based on refinement of the relocation areas after publication of the DEIS. Approximately 2,384 acres in the upland portion of the Shasta Lake and vicinity area could be disturbed, but the likely area of disturbance is about 698 acres. The environmental commitments common to all action alternatives include implementation of best management practices, preparation and implementation of a SWPPP, and development and implementation of site-specific revegetation plans. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Construction-related erosion will be avoided and minimized via implementation of the SWPPP (i.e., erosion and sediment control plans, including site revegetation) that is a part of the environmental commitments common to all action alternatives. These plans will address the local requirements regarding erosion control and site revegetation, and would implement best management practices for erosion and sediment control. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Geo-7 (CP3): Location of Project Facilities on a Geologic Unit or Soil that Is Unstable, or that Would Become Unstable as a Result of the Project, and Potentially Result in Subsidence CP3 is similar to CP1 with respect to its potential to cause or be affected by subsidence. For the same reasons as apply to CP1, this would be less than significant for CP3, because detailed, site-specific geologic and foundation investigations will be completed to inform project design as to how to avoid potential subsidence from these causes. Mitigation for this impact is not needed, and thus not proposed.

Impact Geo-8 (CP3): Failure of Septic Tanks or Alternative Wastewater Disposal Systems Due to Soils that are Unsuited to Land Application of Waste CP3 is similar to CP1 with respect to its potential to cause or be affected by failure of septic tanks or alternative wastewater disposal systems due to soils that are unsuited to land application of waste. For the same reasons as apply to CP1, this would be less than significant for CP3 because relocated wastewater facilities would be designed and constructed to satisfy the conditions of the Shasta County Environmental Health Division Sewage Disposal System Permit. Mitigation for this impact is not needed, and thus not proposed.

Upper Sacramento River (Shasta Dam to Red Bluff) This section describes impacts on the upper Sacramento River portion of the primary study area associated with CP3.

Impact Geo-9 (CP3): Potential Increase in Channel Erosion and Meander Migration It is not anticipated that implementation of CP3 would lead to increased channel erosion and meander migration as compared to the No-Action Alternative and existing conditions. However, by altering storage and operations at Shasta Lake as compared to the No-Action Alternative and existing conditions, this alternative would change the maximum pool elevation and seasonal pool elevations at Shasta Lake and the flow regime in the Sacramento River and potentially several other reservoirs and downstream waterways. Alterations to river flows have the potential to alter downstream stream erosion and change downstream geomorphologic characteristics. However, the frequency and duration of high-flow events resulting from this action are expected to be reduced as compared to existing conditions with current operations. Therefore, downstream erosion would not be anticipated to increase. An erosion and sediment control plan would be implemented, as described in Section 2.3.2, “Environmental Commitments Common to All Action Alternatives,” in Chapter 2, “Alternatives,” to control any short-term and long-term erosion and sedimentation effects of construction activities. This impact would be less than significant.

This impact would be very similar to Impact Geo-9 (CP1), except the modification of flow regimes would be greater under CP3. This impact would be less than significant. Mitigation for this impact is not needed. However, mitigation for this impact is proposed in Section 4.3.5 to further reduce the impact.

Impact Geo-10 (CP3): Substantial Soil Erosion or Loss of Topsoil Due to Construction Under CP3, no gravel augmentation activities would occur.

Therefore, no soil additional soil erosion would be anticipated on the banks along the river channel. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact Geo-11 (CP3): Alteration of Fluvial Geomorphology Under CP3, no potential upper Sacramento River restoration activities would occur. Therefore, no changes in fluvial geomorphology would be anticipated. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact Geo-12 (CP3): Alteration of Downstream Tributary Fluvial Geomorphology Due to Shasta Dam Operations Under CP3, the fluvial geomorphology of downstream tributaries would not be affected by changes in Sacramento River stage attributed to Shasta Dam operations. Small increases in Sacramento River stage may occur with implementation of CP3. However, the frequency and duration of high-flow events resulting from CP3 implementation are expected to be reduced as compared to existing conditions with current operations. This impact would be less than significant.

Where they occur, geomorphic changes (headcutting, channel incisement, etc.) in major tributaries in Cow, Clear and Cottonwood creeks has been directly attributed to the presence of dams (on Clear Creek) and past and current instream gravel mining on the tributaries themselves. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta This section describes impacts on the lower Sacramento River and Delta portions of the extended study area associated with CP3.

Impact Geo-13 (CP3): Substantial Increase in Channel Erosion and Meander Migration It is not anticipated that implementation of CP3 would lead to increased channel erosion and meander migration as compared to the No-Action Alternative and existing conditions. Under CP3, there would be a potential reduction in high-flow events. Therefore, increases in Sacramento River flow would be limited and effects on reservoirs and rivers in the extended study area would be attenuated and dissipated by the large number of these water bodies, as well as by flood bypasses in the extended study area. This impact would be less than significant.

This impact would be very similar to Impact Geo-9 (CP1), except the modification of flow regimes would be greater under CP3. However, the effects of increases in Sacramento River flow in the extended study area would be limited and effects on reservoirs and rivers would be attenuated and dissipated. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CVP/SWP Service Areas This section describes impacts on the CVP/SWP service areas within the extended study area associated with CP3.

Impact Geo-14 (CP3): Substantial Increase in Channel Erosion and Meander Migration It is not anticipated that implementation of CP3 would lead to increased channel erosion and meander migration as compared to the No-Action Alternative and existing conditions. Changes in water operations in the CVP/SWP service areas could potentially result in small changes in flow in the American and Feather rivers, as a result of operations at Folsom Dam and Oroville Dam. However, changes in flow affecting these reservoirs and rivers in the extended study area would be within the normal range of conditions and would not be expected to result in an increase in channel erosion or meander migration. This impact would be less than significant.

This impact would be very similar to Impact Geo-9 (CP1), except the modification of flow regimes would be slightly greater under CP3. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CP4 and CP4A – 18.5-Foot Dam Raise, Anadromous Fish Focus With Water Supply Reliability

This section describes impacts associated with CP4 and CP4A, which focus on increasing the volume of cold water available to the Shasta Dam temperature control device through reservoir reoperations, and on raising Shasta Dam by 18.5 feet. The dam raise would increase the reservoir's full pool by 20.5 feet, and enlarge total storage space by 634,000 acre-feet.

For CP4, of the increased reservoir storage space, about 378,000 acre-feet would be dedicated to increasing the supply of cold water for anadromous fish survival purposes. Operations for the remaining portion of increased storage (approximately 256,000 acre-feet) would be the same as under CP1, with 70,000 acre-feet and 35,000 acre-feet reserved to specifically focus on increasing M&I deliveries during dry and critical years, respectively. Because CP4 would increase the active or useable storage in Shasta Reservoir by the same amount as under CP1, and the storage would be used under the same operational rules, releases from Shasta would be the same as under CP1. The additional storage that would be dedicated to increasing the supply of cold water, or the cold-water pool, would result in different Shasta storages and elevations, but not in any other downstream water operations.

For CP4A, of the increased reservoir storage space, about 191,000 acre-feet would be dedicated to increasing the supply of cold water for anadromous fish survival purposes. Operations for the remaining portion of increased storage (approximately 443,000 acre-feet) would be the same as under CP2, with 120,000 acre-feet and 60,000 acre-feet reserved to specifically focus on increasing M&I deliveries during dry and critical years, respectively. Because CP4A would increase the active or useable storage in Shasta Reservoir by the same amount as under CP2, and the storage would be used under the same operational rules, releases from Shasta would be the same as under CP2. The additional storage that would be dedicated to increasing the supply of cold water, or the cold-water pool, would result in different Shasta storages and elevations, but not in any other downstream water operations.

Construction activities for CP4 and CP4A are identical. The construction activities and potential borrow sources associated with CP4 or CP4A are described in Section 2.3.8 in Chapter 2, “Alternatives.”

Shasta Lake and Vicinity This section describes impacts on the Shasta Lake portion of the primary study area for CP4 and CP4A.

Impact Geo-1 (CP4 and CP4A): Exposure of Structures and People to Geologic Hazards Resulting from Seismic Conditions, Slope Instability, and Volcanic Eruption The implementation of CP4 or CP4A has the potential to increase the exposure of structures and people to geologic hazards similar to CP1. For the same reasons as apply to CP1, impacts resulting from seismic conditions would be less than significant for CP4 or CP4A. Mitigation for this impact is not needed, and thus not proposed.

Like CP3, under CP4 or CP4A, the pool level increase would inundate 173 acres of mapped slope instability hazards. Relocation of infrastructure under CP4 or CP4A would occur in the vicinity of mapped slope instability hazards to the same extent as under CP3 (up to about 232 acres). For the same reasons as apply to CP1, impacts resulting from slope instability hazards would be less than significant for CP4 or CP4A. Mitigation for this impact is not needed, and thus not proposed.

For the same reasons as apply to CP1, impacts resulting from hazards associated with volcanic eruptions would be less than significant for CP4 or CP4A.

No active faults are known to be present within or immediately adjacent to the Shasta Lake and vicinity area, and there is a low risk of fault rupture (CDMG 2006a). According to LaForge and Hawkins (1986), Jennings (1994), and the California Department of Conservation, Division of Mines and Geology (1997), all known faults around the Shasta Lake and vicinity area are classified as inactive. (Inactive faults show no evidence of movement in the last 10,000 years (i.e., Holocene).) Because there are few active faults in close proximity to the Shasta Lake and vicinity area, the likelihood of strong seismic ground shaking also is low. Detailed, site-specific geologic and foundation investigations will be completed to develop design criteria to withstand reasonably probable seismic events.

There is the potential for Reservoir Triggered Seismicity (RTS), seismicity resulting from the impoundment of water at or near the Lake Shasta reservoir. However, proper seismic hazard analyses will be performed and the design earthquake will be correctly defined to mitigate for any potential hazards. RTS is characterized as: seismic events that are more frequent than background levels before impoundment; an increase in both frequency and magnitude of earthquake events resulting from large oscillations of storage levels; and triggered events that tend to decrease to background levels after peaking. To identify an RTS event, an appropriate local seismic network capable of recording microseismic events would be monitored and evaluated. By following the seismic design criteria, an impact resulting from RTS would be mitigated to less than significant. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

This impact would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact Geo-2 (CP4 and CP4A): Alteration of Fluvial Geomorphology and Hydrology of Aquatic Habitats Like CP3, under CP4 or CP4A stream channel equilibrium and geomorphology would be affected by an increase in full pool level. Inundation of lower gradient streams draining to Shasta Lake could result in long-term changes to channel equilibrium by changing the sediment transport capacity of the stream channels between 1,070 and 1,090 feet of elevation. This impact would be significant for CP4 or CP4A.

Based on a GIS-generated stream network, the total stream length inundated as a result of CP4 or CP4A would be the same as for CP3, about 36.5 miles (see Figure 4-17). This value equates to about 1.3 percent of the total length of the streams in watersheds that are directly adjacent and contributory to Shasta Lake. Of the 36.5 miles inundated, 716 stream segments totaling about 12.1 miles of streams with a gradient less than 10 percent would be affected to some degree.

Within the drawdown zone, there would be some benefit to channels with implementation of the environmental commitment to introduce brush structures, large wood, and/or boulder/rock clusters at various locations within low gradient reaches of perennial channels.

The increase in full pool would affect channels by altering fluvial geomorphology and the hydrology of aquatic habitats as described above.

This impact would be significant for CP4. Mitigation for this impact is proposed in Section 4.3.5.

This impact would be significant for CP4A. Mitigation for this impact is proposed in Section 4.3.5.

Impact Geo-3 (CP4 and CP4A): Loss or Diminished Availability of Known Mineral Resources that Would Be of Future Value to the Region The implementation of CP4 or CP4A has the same potential as CP1 to diminish the availability in the region of cement, and of concrete sand and aggregate.

For the same reasons as apply to CP1, this impact would be significant for CP4. Mitigation for this impact is not proposed in Section 4.3.5 because no feasible mitigation is available to reduce the impact to a less-than-significant level.

For the same reasons as apply to CP1, this impact would be significant for CP4A. Mitigation for this impact is not proposed in Section 4.3.5 because no feasible mitigation is available to reduce the impact to a less-than-significant level.

Impact Geo-4 (CP4 and CP4A): Lost or Diminished Soil Biomass Productivity Like CP3, under CP4 or CP4A soil productivity would be lost due to periodic inundation caused by increasing the full pool elevation and by construction, including relocation of infrastructure. The acreages of these losses would be the same as those reported for CP3.

This impact would be significant for CP4. Mitigation for this impact is not proposed in Section 4.3.5 because no feasible mitigation is available to reduce the impact to a less-than-significant level.

This impact would be significant for CP4A. Mitigation for this impact is not proposed in Section 4.3.5 because no feasible mitigation is available to reduce the impact to a less-than-significant level.

Impact Geo-5 (CP4 and CP4A): Substantial Soil Erosion or Loss of Topsoil Due to Shoreline Processes Under CP4 or CP4A, the area of shoreline that would be inundated would be the same as the area reported under CP3, about 2,498 acres. Substantial soil erosion and loss of topsoil would result. The previous descriptions of the time steps and associated volumes of soil lost due to shoreline processes under CP3 also apply to CP4 or CP4A. This impact would be significant for CP4 or CP4A.

Soil erosion due to shoreline processes is estimated to be 767,000 cubic yards per year, assuming the available vegetation removal prescriptions between 1,070-foot and 1,090-foot contours would occur in the first 15 years after the raising of Shasta Dam.

This impact would be significant for CP4. Mitigation for this impact is not proposed in Section 4.3.5 because no feasible mitigation is available to reduce the impact to a less-than-significant level.

This impact would be significant for CP4A. Mitigation for this impact is not proposed in Section 4.3.5 because no feasible mitigation is available to reduce the impact to a less-than-significant level.

Impact Geo-6 (CP4 and CP4A): Substantial Soil Erosion or Loss of Topsoil Due to Upland Processes CP4 and CP4A are similar to CP3 with respect to their potential to cause substantial soil erosion or loss of topsoil due to upland processes.

Interpretations of soil susceptibility to erosion are presented in Table 4-12 for the portion of the area that potentially would be disturbed by construction activities. The values in this table were updated based on refinement of the relocation areas after publication of the DEIS. Approximately 2,384 acres in the upland portion of the Shasta Lake and vicinity area could be disturbed, but the likely area of disturbance is about 698 acres. The environmental commitments common to all action alternatives include implementation of best management practices, preparation and implementation of a SWPPP, and development and implementation of site-specific revegetation plans. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Construction-related erosion will be avoided and minimized via implementation of the SWPPP (i.e., erosion and sediment control plans, including site revegetation) that is a part of the environmental commitments common to all action alternatives. These plans will address the local requirements regarding erosion control and site revegetation, and would implement best management practices for erosion and sediment control.

This impact would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

This impact would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact Geo-7 (CP4 and CP4A): Location of Project Facilities on a Geologic Unit or Soil that Is Unstable, or that Would Become Unstable as a Result of the Project, and Potentially Result in Subsidence CP4 and CP4A are similar to CP1 with respect to their potential to cause or be affected by subsidence.

For the same reasons as apply to CP1, this impact would be less than significant for CP4, because detailed, site-specific geologic and foundation investigations will be completed to inform project design as to how to avoid potential subsidence from these causes. Mitigation for this impact is not needed, and thus not proposed.

For the same reasons as apply to CP1, this impact would be less than significant for CP4A, because detailed, site-specific geologic and foundation investigations will be completed to inform project design as to how to avoid potential subsidence from these causes. Mitigation for this impact is not needed, and thus not proposed.

Impact Geo-8 (CP4 and CP4A): Failure of Septic Tanks or Alternative Wastewater Disposal Systems Due to Soils that are Unsuited to Land Application of Waste CP4 and CP4A are similar to CP1 with respect to their potential to cause or be affected by failure of septic tanks or alternative wastewater disposal systems due to soils that are unsuited to land application of waste.

For the same reasons as apply to CP1, this impact would be less than significant for CP4, because relocated wastewater facilities would be designed and constructed to satisfy the conditions of the Shasta County Environmental Health

Division Sewage Disposal System Permit. Mitigation for this impact is not needed, and thus not proposed.

For the same reasons as apply to CP1, this impact would be less than significant for CP4A, because relocated wastewater facilities would be designed and constructed to satisfy the conditions of the Shasta County Environmental Health Division Sewage Disposal System Permit. Mitigation for this impact is not needed, and thus not proposed.

Upper Sacramento River (Shasta Dam to Red Bluff) This section describes impacts on the upper Sacramento River portion of the primary study area associated with CP4 and CP4A.

Impact Geo-9 (CP4 and CP4A): Potential Increase in Channel Erosion and Meander Migration It is not anticipated that implementation of CP4 or CP4A would lead to increased channel erosion and meander migration as compared to the No-Action Alternative and existing conditions. However, by altering storage and operations at Shasta Lake as compared to the No-Action Alternative and existing conditions, this alternative would change the maximum pool elevation and seasonal pool elevations at Shasta Lake and the flow regime in the Sacramento River and potentially several other reservoirs and downstream waterways. Alterations to river flows have the potential to alter downstream stream erosion and change downstream geomorphologic characteristics. However, the frequency and duration of high-flow events resulting from this action are expected to be reduced as compared to existing conditions with current operations. Therefore, downstream erosion would not be anticipated to increase. An erosion and sediment control plan would be implemented, as described in Section 2.3.2, “Environmental Commitments Common to All Action Alternatives,” in Chapter 2, “Alternatives,” to control any short-term and long-term erosion and sedimentation effects of construction activities. This impact would be less than significant for CP4 or CP4A.

This impact would be the same as Impact Geo-9 (CP1) and would be less than significant for CP4. Mitigation for this impact is not needed. However, mitigation for this impact is proposed in Section 4.3.5 to further reduce the impact.

This impact would be the same as Impact Geo-9 (CP1) and would be less than significant for CP4A. Mitigation for this impact is not needed. However, mitigation for this impact is proposed in Section 4.3.5 to further reduce the impact.

Impact Geo-10 (CP4 and CP4A): Substantial Soil Erosion or Loss of Topsoil Due to Construction CP4 or CP4A involve replenishing spawning gravel in the Upper Sacramento River between Keswick Dam and Red Bluff Pumping Plant. Implementation of these activities could potentially contribute to soil erosion or loss of topsoil from clearing, grading, and grubbing activities required while constructing roadways to access the new spawning gravel sites. In addition, soil erosion could also potentially occur at sites where clearing and grubbing of the river bank would be required to allow the gravel to be placed on the river bank for recruitment. An erosion and sediment control plan would be implemented, as described in Section 2.3.2, "Environmental Commitments Common to All Action Alternatives," in Chapter 2, "Alternatives," to control any short-term and long-term erosion and sedimentation effects of construction activities.

This impact would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

This impact would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact Geo-11 (CP4 and CP4A): Alteration of Fluvial Geomorphology Under CP4 or CP4A, riparian, floodplain, and side-channel habitat restoration would be constructed at one or a combination of potential locations along the upper Sacramento River. Descriptions of restoration measures for six potential sites, referred to collectively as upper Sacramento River restoration sites, are detailed in the Downstream Restoration Technical Memorandum. Stream restoration activities could potentially cause changes in fluvial geomorphology that could result in channelized or unstable braided streams, depending on the gradient of the channel and specific restoration activities. However, restoration of habitat through planting of native vegetation would stabilize channel banks.

This impact would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

This impact would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact Geo-12 (CP4 and CP4A): Alteration of Downstream Tributary Fluvial Geomorphology Due to Shasta Dam Operations Under CP4 or CP4A, the fluvial geomorphology of downstream tributaries would not be affected by changes in Sacramento River stage attributed to Shasta Dam operations. Small increases in Sacramento River stage may occur with implementation of CP4 or CP4A. However, the frequency and duration of high-flow events resulting from CP4 or CP4A implementation are expected to be reduced as compared to existing conditions with current operations. Under CP4, there would be a potential reduction in high-flow events similar to CP1. Under CP4A, there would be a potential reduction in high-flow events similar to CP2. This impact would be less than significant.

Where they occur, geomorphic changes (headcutting, channel incisement, etc.) in major tributaries in Cow, Clear and Cottonwood creeks has been directly attributed to the presence of dams (on Clear Creek) and past and current instream gravel mining on the tributaries themselves. This impact would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

This impact would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta This section describes impacts on the lower Sacramento River and Delta portions of the extended study area associated with CP4 and CP4A.

Impact Geo-13 (CP4 and CP4A): Substantial Increase in Channel Erosion and Meander Migration It is not anticipated that implementation of CP4 or CP4A would lead to increased channel erosion and meander migration as compared to the No-Action Alternative and existing conditions. Under CP4, there would be a potential reduction in high-flow events similar to CP1. Under CP4A, there would be a potential reduction in high-flow events similar to CP2. Therefore, increases in Sacramento River flow would be limited and effects on reservoirs and rivers in the extended study area would be attenuated and dissipated by the large number of these water bodies, as well as by flood bypasses in the extended study area. This impact would be less than significant for CP4 or CP4A.

This impact would be similar to Impact Geo-9 (CP1) and would be less than significant for CP4. Effects of increases in Sacramento River flow in the extended study area would be limited and effects on reservoirs and rivers would be attenuated and dissipated. Mitigation for this impact is not needed, and thus not proposed.

This impact would be similar to Impact Geo-9 (CP2) and would be less than significant for CP4A. Effects of increases in Sacramento River flow in the extended study area would be limited and effects on reservoirs and rivers would be attenuated and dissipated. Mitigation for this impact is not needed, and thus not proposed.

CVP/SWP Service Areas This section describes impacts on the CVP/SWP service areas within the extended study area associated with CP4 and CP4A.

Impact Geo-14 (CP4 and CP4A): Substantial Increase in Channel Erosion and Meander Migration It is not anticipated that implementation of CP4 or CP4A would lead to increased channel erosion and meander migration as compared to the No-Action Alternative and existing conditions. Changes in water operations in the CVP/SWP service areas could potentially result in small changes in flow in the American and Feather rivers, as a result of operations at Folsom Dam and Oroville Dam. However, changes in flow affecting these reservoirs and rivers in the extended study area would be within the normal range of conditions and would not be expected to result in an increase in channel erosion or meander migration. This impact would be less than significant for CP4 or CP4A.

This impact would be the same as Impact Geo-9 (CP1) and would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

This impact would be the same as Impact Geo-9 (CP2) and would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

CP5 – 18.5-Foot Dam Raise, Combination Plan

This section describes impacts associated with CP5, which includes raising Shasta Dam 18.5 feet. This alternative also includes (1) implementing environmental restoration features along the lower reaches of major tributaries to Shasta Lake, (2) constructing shoreline fish habitat around Shasta Lake, and (3) constructing additional and/or improved recreation features at various locations around Shasta Lake to increase the value of the recreational experience. The dam raise would increase the reservoir's full pool elevation by 20.5 feet to about 1,090 feet above msl, and enlarge total storage space by 634,000 acre-feet. Section 2.3.8 in Chapter 2, "Alternatives," describes the construction activities and potential borrow sources associated with CP5.

Shasta Lake and Vicinity This section describes impacts on the Shasta Lake portion of the primary study area for CP5.

Impact Geo-1 (CP5): Exposure of Structures and People to Geologic Hazards Resulting from Seismic Conditions, Slope Instability, and Volcanic Eruption Implementing CP5 has the potential to increase the exposure of structures and people to geologic hazards similar to CP1. For the same reasons as apply to CP1, impacts resulting from seismic conditions would be less than significant for CP5.

Like CP3, under CP5, the pool level increase would inundate 173 acres of mapped slope instability hazards. Relocation of infrastructure under CP5 would occur in the vicinity of mapped slope instability hazards to a similar but greater extent than under CP4 and CP4A (up to about 232 acres). For the same reasons as apply to CP1, impacts resulting from slope instability hazards would be less than significant for CP5.

For the same reasons as apply to CP1, impacts resulting from hazards associated with volcanic eruptions would be less than significant for CP5.

No active faults are known to be present within or immediately adjacent to the Shasta Lake and vicinity area, and there is a low risk of fault rupture (CDMG 2006a). According to LaForge and Hawkins (1986), Jennings (1994), and the California Department of Conservation, Division of Mines and Geology (1997), all known faults around the Shasta Lake and vicinity area are classified as inactive. (Inactive faults show no evidence of movement in the last 10,000 years (i.e., Holocene).) Because there are few active faults in close proximity to the

Shasta Lake and vicinity area, the likelihood of strong seismic ground shaking also is low. Detailed, site-specific geologic and foundation investigations will be completed to develop design criteria to withstand reasonably probable seismic events.

There is the potential for Reservoir Triggered Seismicity (RTS), seismicity resulting from the impoundment of water at or near the Lake Shasta reservoir. However, proper seismic hazard analyses will be performed and the design earthquake will be correctly defined to mitigate for any potential hazards. RTS is characterized as: seismic events that are more frequent than background levels before impoundment; an increase in both frequency and magnitude of earthquake events resulting from large oscillations of storage levels; and triggered events that tend to decrease to background levels after peaking. To identify an RTS event, an appropriate local seismic network capable of recording microseismic events would be monitored and evaluated. By following the seismic design criteria, an impact resulting from RTS would be mitigated to less than significant. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

This impact would be less than significant for CP5. Mitigation for this impact is not needed, and thus not proposed.

Impact Geo-2 (CP5): Alteration of Fluvial Geomorphology and Hydrology of Aquatic Habitats Like CP3, under CP5 stream channel equilibrium and geomorphology would be affected by an increase in full pool level. Inundation of lower gradient streams draining to Shasta Lake could result in long-term changes to channel equilibrium by changing the sediment transport capacity of the stream channels between 1,070 and 1,090 feet of elevation. This impact would be significant.

Based on a GIS-generated stream network, the total stream length inundated as a result of CP5 would be the same as for CP3, about 36.5 miles (see Figure 4-17). This value equates to about 1.3 percent of the total length of the streams in watersheds that are directly adjacent and contributory to Shasta Lake. Of the 36.5 miles inundated, 716 stream segments totaling about 12.1 miles of streams with a gradient less than 10 percent would be affected to some degree.

Within the drawdown zone, channels would be benefit to some degree with implementation of the environmental commitment to introduce brush structures, large wood, and/or boulder/rock clusters at various locations within low gradient reaches of perennial channels.

The increase in full pool would affect channels by altering fluvial geomorphology and the hydrology of aquatic habitats as described above. This impact would be significant. Mitigation for this impact is proposed in Section 4.3.5.

Impact Geo-3 (CP5): Lost or Diminished Availability of Known Mineral Resources that Would Be of Future Value to the Region Implementing CP5 has the same potential as CP1 to diminish the availability in the region of cement, concrete sand, and aggregate. For the same reasons that apply to CP1, this impact would be significant. Mitigation for this impact is not proposed in Section 4.3.5 because no feasible mitigation is available to reduce the impact to a less-than-significant level.

Impact Geo-4 (CP5): Lost or Diminished Soil Biomass Productivity Like CP3, under CP5 soil productivity would be lost due to periodic inundation caused by increasing the full pool elevation and by construction including relocation of infrastructure. The acreages of these losses would be the same as those reported for CP3.

This impact would be significant. Mitigation for this impact is not proposed in Section 4.3.5 because no feasible mitigation is available to reduce the impact to a less-than-significant level.

Impact Geo-5 (CP5): Substantial Soil Erosion or Loss of Topsoil Due to Shoreline Processes Under CP5, the area of shoreline that would be inundated would be the same as the area reported under CP3, about 2,498 acres. Substantial soil erosion and loss of topsoil would result. The previous descriptions of the time steps and associated volumes of soil lost due to shoreline processes under CP3 also apply to CP5.

Soil erosion due to shoreline processes is estimated to be 767,000 cubic yards per year, assuming the available vegetation removal prescriptions between 1,070-foot and 1,090-foot contours would occur in the first 15 years after the raising of Shasta Dam. This impact would be significant. Mitigation for this impact is not proposed in Section 4.3.5 because no feasible mitigation is available to reduce the impact to a less-than-significant level.

Impact Geo-6 (CP5): Substantial Soil Erosion or Loss of Topsoil Due to Upland Processes CP5 is similar to CP3 with respect to its potential to cause substantial soil erosion or loss of topsoil due to upland processes.

Interpretations of soil susceptibility to erosion are presented in Table 4-12 for the portion of the area that potentially would be disturbed by construction activities. The values in this table were updated based on refinement of the relocation areas after publication of the DEIS. Approximately 2,384 acres in the upland portion of the Shasta Lake and vicinity area could be disturbed, but the likely area of disturbance is about 698 acres. The environmental commitments common to all action alternatives include implementation of best management practices, preparation and implementation of a SWPPP, and development and implementation of site-specific revegetation plans. This impact would be less than significant.

Construction-related erosion will be avoided and minimized via implementation of the SWPPP (i.e., erosion and sediment control plans, including site revegetation) that is a part of the environmental commitments common to all action alternatives. These plans will address the local requirements regarding erosion control and site revegetation, and would implement best management practices for erosion and sediment control. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Geo-7 (CP5): Location of Project Facilities on a Geologic Unit or Soil that Is Unstable, or that Would Become Unstable as a Result of the Project, and Potentially Result in Subsidence CP5 is similar to CP1 with respect to its potential to cause or be affected by subsidence. For the same reasons as apply to CP1, this impact would be less than significant for CP5, because detailed, site-specific geologic and foundation investigations will be completed to inform project design as to how to avoid potential subsidence from these causes. Mitigation for this impact is not needed, and thus not proposed.

Impact Geo-8 (CP5): Failure of Septic Tanks or Alternative Wastewater Disposal Systems Due to Soils that are Unsuited to Land Application of Waste CP5 is similar to CP1 with respect to its potential to cause or be affected by failure of septic tanks or alternative wastewater disposal systems due to soils that are unsuited to land application of waste. For the same reasons as apply to CP1, this impact would be less than significant for CP5, because relocated wastewater facilities would be designed and constructed to satisfy the conditions of the Shasta County Environmental Health Division Sewage Disposal System Permit. Mitigation for this impact is not needed, and thus not proposed.

Upper Sacramento River (Shasta Dam to Red Bluff) This section describes impacts on the upper Sacramento River portion of the primary study area associated with CP5.

Impact Geo-9 (CP5): Potential Increase in Channel Erosion and Meander Migration It is not anticipated that implementation of CP5 would lead to increased channel erosion and meander migration as compared to the No-Action Alternative and existing conditions. However, by altering storage and operations at Shasta Lake as compared to the No-Action Alternative and existing conditions, this alternative would change the maximum pool elevation and seasonal pool elevations at Shasta Lake and the flow regime in the Sacramento River and potentially several other reservoirs and downstream waterways. Alterations to river flows have the potential to alter downstream stream erosion and change downstream geomorphologic characteristics. However, the frequency and duration of high-flow events resulting from this action are expected to be reduced as compared to existing conditions with current operations. Therefore, downstream erosion would not be anticipated to increase. An erosion and sediment control plan would be implemented, as described in Section 2.3.2, “Environmental Commitments Common to All

Action Alternatives," in Chapter 2, "Alternatives," to control any short-term and long-term erosion and sedimentation effects of construction activities. This impact would be less than significant. Mitigation for this impact is not needed. However, mitigation for this impact is proposed in Section 4.3.5 to further reduce the impact.

Impact Geo-10 (CP5): Substantial Soil Erosion or Loss of Topsoil Due to Construction CP5 involves replenishing spawning gravel in the Upper Sacramento River between Keswick Dam and Red Bluff Pumping Plant. Implementation of these activities could potentially contribute to soil erosion or loss of topsoil from clearing, grading, and grubbing activities required while constructing roadways to access the new spawning gravel sites. In addition, soil erosion could also potentially occur at sites where clearing and grubbing of the river bank would be required to allow the gravel to be placed on the river bank for recruitment. An erosion and sediment control plan would be implemented, as described in Section 2.3.2, "Environmental Commitments Common to All Action Alternatives," in Chapter 2, "Alternatives," to control any short-term and long-term erosion and sedimentation effects of construction activities. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Geo-11 (CP5): Alteration of Fluvial Geomorphology Under CP5, riparian, floodplain, and side-channel habitat restoration would be constructed at one or a combination of potential locations along the upper Sacramento River. Descriptions of restoration measures for six potential sites, referred to collectively as upper Sacramento River restoration sites, are detailed in the Downstream Restoration Technical Memorandum. Stream restoration activities could potentially cause changes in fluvial geomorphology that could result in channelized or unstable braided streams depending on the gradient of the channel and specific restoration activities. However, restoration of habitat through planting of native vegetation would stabilize channel banks. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Geo-12 (CP5): Alteration of Downstream Tributary Fluvial Geomorphology Due to Shasta Dam Operations Under CP5, the fluvial geomorphology of downstream tributaries would not be affected by changes in Sacramento River stage attributed to Shasta Dam operations. Small increases in Sacramento River stage may occur with implementation of CP5. However, the frequency and duration of high-flow events resulting from CP5 implementation are expected to be reduced as compared to existing conditions with current operations. This impact would be less than significant.

Where they occur, geomorphic changes (headcutting, channel incisement, etc.) in major tributaries in Cow, Clear and Cottonwood creeks has been directly attributed to the presence of dams (on Clear Creek) and past and current instream gravel mining on the tributaries themselves. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta This section describes impacts on the lower Sacramento River and Delta portions of the extended study area associated with CP5.

Impact Geo-13 (CP5): Substantial Increase in Channel Erosion and Meander Migration It is not anticipated that implementation of CP5 would lead to increased channel erosion and meander migration as compared to the No-Action Alternative and existing conditions. With implementation of CP5, there would be a potential reduction in high-flow events. Therefore, increases in Sacramento River flow would be limited and effects on reservoirs and rivers in the extended study area would be attenuated and dissipated by the large number of these water bodies, as well as by flood bypasses in the extended study area. This impact would be less than significant.

This impact would be less than significant. Effects of increases in Sacramento River flow in the extended study area would be limited and effects on reservoirs and rivers would be attenuated and dissipated. Mitigation for this impact is not needed, and thus not proposed.

CVP/SWP Service Areas This section describes impacts on the CVP/SWP service areas within the extended study area associated with CP5.

Impact Geo-14 (CP5): Substantial Increase in Channel Erosion and Meander Migration It is not anticipated that implementation of CP5 would lead to increased channel erosion and meander migration as compared to the No-Action Alternative and existing conditions. Changes in water operations in the CVP/SWP service areas could potentially result in small changes in flow in the American and Feather rivers, as a result of operations at Folsom Dam and Oroville Dam. However, changes in flow affecting these reservoirs and rivers in the extended study area would be within the normal range of conditions and would not be expected to result in an increase in channel erosion or meander migration. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

4.3.5 Mitigation Measures

This section discusses mitigation measures for each significant impact described in the environmental consequences section, as presented in Table 4-13.

Table 4-13. Summary of Mitigation Measures for Geology, Geomorphology, Minerals, and Soils

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/CP4A	CP5
Impact Geo-1: Exposure of Structures and People to Geologic Hazards Resulting from Seismic Conditions, Slope Instability, and Volcanic Eruptions	LOS before Mitigation	NI	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS
Impact Geo-2: Alteration of Fluvial Geomorphology and Hydrology of Aquatic Habitats	LOS before Mitigation	NI	S	S	S	S	S
	Mitigation Measure	None required.	Mitigation Measure Geo-2: Replace Lost Ecological Functions of Aquatic Habitats by Restoring Existing Degraded Aquatic Habitats in the Vicinity of the Impact.				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS
Impact Geo-3: Loss or Diminished Availability of Known Mineral Resources That Would Be of Future Value to the Region	LOS before Mitigation	NI	S	S	S	S	S
	Mitigation Measure	None required.	No feasible mitigation is available to reduce impact.				
	LOS after Mitigation	NI	SU	SU	SU	SU	SU
Impact Geo-4: Lost or Diminished Soil Biomass Productivity	LOS before Mitigation	NI	S	S	S	S	S
	Mitigation Measure	None required	No feasible mitigation is available to reduce impact.				
	LOS after Mitigation	NI	SU	SU	SU	SU	SU
Impact Geo-5: Substantial Soil Erosion or Loss of Topsoil Due to Shoreline Processes	LOS before Mitigation	NI	S	S	S	S	S
	Mitigation Measure	None required	No feasible mitigation is available to reduce impact.				
	LOS after Mitigation	NI	SU	SU	SU	SU	SU

Table 4-13. Summary of Mitigation Measures for Geology, Geomorphology, Minerals, and Soils (contd.)

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/CP4A	CP5
Impact Geo-6: Substantial Soil Erosion or Loss of Topsoil Due to Upland Processes	LOS before Mitigation	NI	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS
Impact Geo-7: Be Located on a Geologic Unit or Soil that Is Unstable, or that Would Become Unstable as a Result of the Project, and Potentially Result in Subsidence	LOS before Mitigation	NI	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS
Impact Geo-8: Failure of Septic Tanks or Alternative Wastewater Disposal Systems Due to Soils that are Unsuited to Land Application of Waste	LOS before Mitigation	NI	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS
Impact Geo-9: Substantial Increase in Channel Erosion and Meander Migration	LOS before Mitigation	NI	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	Mitigation Measure Geo-9: Modification of Flow Releases in Response to River Management and Habitat Restoration Efforts between Keswick Dam and Red Bluff.				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS
Impact Geo-10: Substantial Soil Erosion or Loss of Topsoil Due to Construction	LOS before Mitigation	NI	NI	NI	NI	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	NI	NI	NI	NI	LTS	LTS

Table 4-13. Summary of Mitigation Measures for Geology, Geomorphology, Minerals, and Soils (contd.)

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/CP4A	CP5
Impact Geo-11: Alteration of Fluvial Geomorphology	LOS before Mitigation	NI	NI	NI	NI	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	NI	NI	NI	NI	LTS	LTS
Impact Geo-12: Alteration of Downstream Tributary Fluvial Geomorphology Due to Shasta Dam Operations	LOS before Mitigation	NI	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS
Impact Geo-13: Substantial Increase in Channel Erosion and Meander Migration (Lower Sacramento River and Delta)	LOS before Mitigation	NI	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS
Impact Geo-14: Substantial Increase in Channel Erosion and Meander Migration (CVP/SWP Service Areas)	LOS before Mitigation	NI	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS

Key:
CP = Comprehensive Plan
CVP = Central Valley Project
LOS = level of significance
LTS = less than significant
NI = No Impact
PS = potentially significant
S = significant
SU = significant and unavoidable
SWP = State Water Project

No-Action Alternative

No mitigation measures are required for this alternative.

CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply

No mitigation is required for Impact Geo-1 (CP1), Impacts Geo-6 (CP1) through Geo-8 (CP1), and Impacts Geo-10 (CP1) through Geo-14 (CP1). No feasible mitigation measures are available at the time of preparation of this EIS to reduce Impacts Geo-3 (CP1) through Geo-5 (CP1) to a less-than-significant level. Therefore, Impacts Geo-3 (CP1), Geo-4 (CP1), and Geo-5 (CP1) would be significant and unavoidable.

Mitigation is provided below for other impacts of CP1 on geology, geomorphology, minerals, and soils. No mitigation is required for Impact Geo-9 (CP1), but mitigation is provided to further reduce this less-than-significant impact.

Mitigation Measure Geo-2 (CP1): Replace Lost Ecological Functions of Aquatic Habitats by Restoring Existing Degraded Aquatic Habitats in the Vicinity of the Impact The loss of 18.5 miles of intermittent and perennial streams (including 6.2 miles of streams with a gradient less than 7 percent) will be mitigated by compensating for the impact by replacing or providing substitute resources or environments. As described in the Preliminary Environmental Commitments and Mitigation Plan Appendix to the EIS, Reclamation convened an interagency working group to enhance mitigation measures presented in the DEIS. This working group had the benefit of additional information from the recently completed Tributary Fisheries Characterization Report (Reclamation 2014). This report, summarized in Chapter 11, “Fisheries and Aquatic Ecosystems,” provides detailed information on tributaries that flow into Shasta Lake, with an emphasis on those channel reaches upstream from the current drawdown zone. The environmental commitments described in Chapter 2, “Alternatives,” and the Preliminary Environmental Commitments and Mitigation Plan of the EIS are intended to address impacts to channels within the existing drawdown zone (1070 msl).

An outcome of the interagency work group discussions was the agreement that this mitigation measure would encompass efforts within the channels actually impacted by this comprehensive plan, but would also be expanded to restore degraded aquatic habitat in channels upstream from Shasta Lake. In general, this mitigation measure would follow the approach to characterize, prioritize and identify specific restoration actions described in the *California Salmonid Stream Habitat Restoration Manual – Fourth Edition* (CDFG 2010).

For CP1, this mitigation measure would result in restoration of up to 18.5 miles of channel, with an emphasis on low gradient perennial channels to be identified by an interagency work group to be convened by Reclamation. This mitigation focuses on restoring and enhancing the aquatic functions of existing, degraded aquatic habitats in or near the Shasta Lake and vicinity area.

This interagency working group would focus on identification of specific tributaries to Shasta Lake that may benefit from various mitigation techniques using available information. Examples of techniques that may be used include channel and bank stabilization, channel redirection, channel reconstruction, culvert replacement and elimination of barriers to fish passage, and enhancement of habitat physical structure (e.g., placement of woody debris, rocks). The nature and extent of the restoration and enhancement activities will be based on an assessment of the ecological functions that are lost as a consequence of implementing this alternative. Implementation of this mitigation measure would reduce Impact Geo-2 (CP1) to a less-than-significant level.

Mitigation Measure Geo-9 (CP1): Modification of Flow Releases in Response to River Management and Habitat Restoration Efforts between Keswick Dam and Red Bluff No mitigation is required for Impact Geo-9 as the result of implementing any proposed alternatives (CP1, CP2, CP3, CP4, CP4A, or CP5). On an annual basis, Reclamation will coordinate with relevant river management and habitat restoration efforts between Keswick Dam and Red Bluff, including but not limited to the members of the Sacramento River Temperature Task Group. The purpose of this coordination will be to discuss how releases from Shasta and Keswick dams could be managed to best enhance downstream objectives, such as ramping rates or temperature targets, that are consistent with the CVP's capabilities and primary operating objectives. Impact Geo-9 (CP1).would be less than significant before mitigation. Implementation of this mitigation measure would further reduce Impact Geo-9 (CP1).

CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply
No mitigation is required for Impact Geo-1 (CP2), Impacts Geo-6 (CP2) through Geo-8 (CP2), and Impacts Geo-10 (CP2) through Geo-14 (CP2). No feasible mitigation measures are available at the time of preparation of this EIS to reduce Impacts Geo-3 (CP2) through Geo-5 (CP2) to a less-than-significant level. Therefore, Impacts Geo-3 (CP2), Geo-4 (CP2), and Geo-5 (CP2) would be significant and unavoidable.

Mitigation is provided below for other impacts of CP2 on geology, geomorphology, minerals, and soils. No mitigation is required for Impact Geo-9 (CP2), but mitigation is provided to further reduce this less-than-significant impact.

Mitigation Measure Geo-2 (CP2): Replace Lost Ecological Functions of Aquatic Habitats by Restoring Existing Degraded Aquatic Habitats in the Vicinity of the Impact The loss of 25.5 miles of intermittent and perennial streams (including 8.2 miles of streams with a gradient less than 7 percent) will be mitigated by compensating for the impact by replacing or providing substitute resources or environments. As described in the Preliminary

Environmental Commitments and Mitigation Plan Appendix to the EIS, Reclamation convened an interagency working group to enhance mitigation measures presented in the DEIS. This working group had the benefit of additional information from the recently completed Tributary Fisheries Characterization Report (Reclamation 2014). This report, summarized in Chapter 11, "Fisheries and Aquatic Ecosystems," provides detailed information on tributaries that flow into Shasta Lake, with an emphasis on those channel reaches upstream from the current drawdown zone. The environmental commitments described in Chapter 2, "Alternatives," and the Preliminary Environmental Commitments and Mitigation Plan of the EIS are intended to address impacts to channels within the existing drawdown zone (1070 msl).

An outcome of the interagency work group discussions was the agreement that this mitigation measure would encompass efforts within the channels actually impacted by this comprehensive plan, but would also be expanded to restore degraded aquatic habitat in channels upstream from Shasta Lake. In general, this mitigation measure would follow the approach to characterize, prioritize and identify specific restoration actions described in the *California Salmonid Stream Habitat Restoration Manual – Fourth Edition* (CDFG 2010).

For CP2, this mitigation measure would result in restoration of up to 22.5 miles of channel, with an emphasis on low gradient perennial channels to be identified by an interagency work group to be convened by Reclamation. This mitigation focuses on restoring and enhancing the aquatic functions of existing, degraded aquatic habitats in or near the Shasta Lake and vicinity area.

This interagency working group would focus on identification of specific tributaries to Shasta Lake that may benefit from various mitigation techniques using available information. Examples of techniques that may be used include channel and bank stabilization, channel redirection, channel reconstruction, culvert replacement and elimination of barriers to fish passage, and enhancement of habitat physical structure (e.g., placement of woody debris, rocks). The nature and extent of the restoration and enhancement activities will be based on an assessment of the ecological functions that are lost as a consequence of implementing this alternative. Implementation of this mitigation measure would reduce Impact Geo-2 (CP2) to a less-than-significant level.

Mitigation Measure Geo-9 (CP2): Modification of Flow Releases in Response to River Management and Habitat Restoration Efforts between Keswick Dam and Red Bluff This mitigation measure is identical to Mitigation Measure Geo-9 (CP1). On an annual basis, Reclamation will coordinate with relevant river management and habitat restoration efforts between Keswick Dam and Red Bluff, including but not limited to the members of the Sacramento River Temperature Task Group. The purpose of this coordination will be to discuss how releases from Shasta and Keswick dams could be managed to best enhance downstream objectives, such as ramping rates or temperature targets, that are consistent with the CVP's capabilities and primary operating objectives. Impact Geo-9 (CP2).would be less than significant before mitigation. Implementation of this mitigation measure would further reduce Impact Geo-9 (CP2).

CP3 – 18.5-Foot Dam Raise, Agricultural Water Supply Reliability and Anadromous Fish Survival

No mitigation is required for Impact Geo-1 (CP3) and Impacts Geo-6 (CP3) through Geo-8 (CP3), and Impacts Geo-10 (CP3) through Geo-14 (CP3). No feasible mitigation measures are available at the time of preparation of this EIS to reduce Impacts Geo-3 (CP3) through Geo-5 (CP3) to a less-than-significant level. Therefore, Impacts Geo-3 (CP3), Geo-4 (CP3), and Geo-5 (CP3) would be significant and unavoidable.

Mitigation is provided below for other impacts of CP3 on geology, geomorphology, minerals, and soils. No mitigation is required for Impact Geo-9 (CP3), but mitigation is provided to further reduce this less-than-significant impact.

Mitigation Measure Geo-2 (CP3): Replace Lost Ecological Functions of Aquatic Habitats by Restoring Existing Degraded Aquatic Habitats in the Vicinity of the Impact The loss of 36.5 miles of intermittent and perennial streams (including 12.1 miles of streams with a gradient less than 7 percent) will be mitigated by compensating for the impact by replacing or providing substitute resources or environments. As described in the Preliminary Environmental Commitments and Mitigation Plan Appendix to the EIS, Reclamation convened an interagency working group to enhance mitigation measures presented in the DEIS. This working group had the benefit of additional information from the recently completed Tributary Fisheries Characterization Report (Reclamation 2014). This report, summarized in Chapter 11, “Fisheries and Aquatic Ecosystems,” provides detailed information on tributaries that flow into Shasta Lake, with an emphasis on those channel reaches upstream from the current drawdown zone. The environmental commitments described in Chapter 2, “Alternatives,” and the Preliminary Environmental Commitments and Mitigation Plan of the EIS are intended to address impacts to channels within the existing drawdown zone (1070 msl).

An outcome of the interagency work group discussions was the agreement that this mitigation measure would encompass efforts within the channels actually impacted by this comprehensive plan, but would also be expanded to restore degraded aquatic habitat in channels upstream from Shasta Lake. In general, this mitigation measure would follow the approach to characterize, prioritize and identify specific restoration actions described in the *California Salmonid Stream Habitat Restoration Manual – Fourth Edition* (CDFG 2010).

For CP3, this mitigation measure would result in restoration of up to 36.5 miles of channel, with an emphasis on low gradient perennial channels to be identified by an interagency work group to be convened by Reclamation. This mitigation focuses on restoring and enhancing the aquatic functions of existing, degraded aquatic habitats in or near the Shasta Lake and vicinity area.

This interagency working group would focus on identification of specific tributaries to Shasta Lake that may benefit from various mitigation techniques using available information. Examples of techniques that may be used include channel and bank stabilization, channel redirection, channel reconstruction, culvert replacement and elimination of barriers to fish passage, and enhancement of habitat physical structure (e.g., placement of woody debris, rocks). The nature and extent of the restoration and enhancement activities will be based on an assessment of the ecological functions that are lost as a consequence of implementing this alternative. Implementation of this mitigation measure would reduce Impact Geo-2 (CP3) to a less-than-significant level.

Mitigation Measure Geo-9 (CP3): Modification of Flow Releases in Response to River Management and Habitat Restoration Efforts between Keswick Dam and Red Bluff This mitigation measure is identical to Mitigation Measure Geo-9 (CP1). On an annual basis, Reclamation will coordinate with relevant river management and habitat restoration efforts between Keswick Dam and Red Bluff, including but not limited to the members of the Sacramento River Temperature Task Group. The purpose of this coordination will be to discuss how releases from Shasta and Keswick dams could be managed to best enhance downstream objectives, such as ramping rates or temperature targets, that are consistent with the CVP's capabilities and primary operating objectives. Impact Geo-9 (CP3).would be less than significant before mitigation. Implementation of this mitigation measure would further reduce Impact Geo-9 (CP3).

CP4 and CP4A – 18.5-Foot Dam Raise, Anadromous Fish Focus With Water Supply Reliability

No mitigation is required for Impact Geo-1 (CP4 and CP4A), Impacts Geo-6 (CP4 and CP4A) through Geo-8 (CP4 and CP4A), and Impacts Geo-10 (CP4 and CP4A) through Geo-14 (CP4 and CP4A). No feasible mitigation measures are available at the time of preparation of this EIS to reduce Impacts Geo-3 (CP4 and CP4A) through Geo-5 (CP4 and CP4A) to a less-than-significant level. Therefore, Impacts Geo-3 (CP4 and CP4A), Geo-4 (CP4 and CP4A), and Geo-5 (CP4 and CP4A) would be significant and unavoidable.

Mitigation is provided below for other impacts of CP4 and CP4A on geology, geomorphology, minerals, and soils. No mitigation is required for Impact Geo-9 (CP4 and CP4A), but mitigation is provided to further reduce this less-than-significant impact.

Mitigation Measure Geo-2 (CP4 and CP4A): Replace Lost Ecological Functions of Aquatic Habitats by Restoring Existing Degraded Aquatic Habitats in the Vicinity of the Impact This mitigation measure is identical to

Mitigation Measure Geo-2 (CP3). Implementation of this mitigation measure would reduce Impact Geo-2 (CP4 and CP4A) to a less-than-significant level.

Mitigation Measure Geo-9 (CP4 and CP4A): Modification of Flow Releases in Response to River Management and Habitat Restoration Efforts between Keswick Dam and Red Bluff This mitigation measure is identical to Mitigation Measure Geo-9 (CP1). On an annual basis, Reclamation will coordinate with relevant river management and habitat restoration efforts between Keswick Dam and Red Bluff, including but not limited to the members of the Sacramento River Temperature Task Group. The purpose of this coordination will be to discuss how releases from Shasta and Keswick dams could be managed to best enhance downstream objectives, such as ramping rates or temperature targets, that are consistent with the CVP's capabilities and primary operating objectives. Impact Geo-9 (CP4 and CP4A).would be less than significant before mitigation. Implementation of this mitigation measure would further reduce Impact Geo-9 (CP4 and CP4A).

CP5 – 18.5-Foot Dam Raise, Combination Plan

No mitigation is required for Impact Geo-1 (CP5), Impacts Geo-6 (CP5) through Geo-8 (CP5), and Impacts Geo-10 (CP5) through Geo-14 (CP5). No feasible mitigation measures are available at the time of preparation of this EIS to reduce Impacts Geo-3 (CP5) through Geo-5 (CP5) to a less-than-significant level. Therefore, Impacts Geo-3 (CP5), Geo-4 (CP5), and Geo-5 (CP5) would be significant and unavoidable.

Mitigation is provided below for other impacts of CP5 on geology, geomorphology, minerals, and soils. No mitigation is required for Impact Geo-9 (CP5), but mitigation is provided to further reduce this less-than-significant impact.

Mitigation Measure Geo-2 (CP5): Replace Lost Ecological Functions of Aquatic Habitats by Restoring Existing Degraded Aquatic Habitats in the Vicinity of the Impact This mitigation measure is identical to Mitigation Measure Geo-2 (CP3). Implementation of this mitigation measure would reduce Impact Geo-2 (CP5) to a less-than-significant level.

Mitigation Measure Geo-9 (CP5): Modification of Flow Releases in Response to River Management and Habitat Restoration Efforts between Keswick Dam and Red Bluff This mitigation measure is identical to Mitigation Measure Geo-9 (CP1). On an annual basis, Reclamation will coordinate with relevant river management and habitat restoration efforts between Keswick Dam and Red Bluff, including but not limited to the members of the Sacramento River Temperature Task Group. The purpose of this coordination will be to discuss how releases from Shasta and Keswick dams could be managed to best enhance downstream objectives, such as ramping rates or temperature targets, that are consistent with the CVP's capabilities and primary operating objectives. Impact Geo-9 (CP5).would be less than significant before mitigation. Implementation of this mitigation measure would further reduce Impact Geo-9 (CP5).

4.3.6 Cumulative Effects

Chapter 3, "Considerations for Describing the Affected Environment and Environmental Consequences," discusses overall cumulative impacts methodology related to the project alternatives, including the relationship to the CALFED Bay-Delta Program PEIS/R cumulative impacts analysis, qualitative and quantitative assessment, past and future actions in the study area, and significance criteria. Table 3-1, "Present and Reasonably Foreseeable Future Actions Included in the Analysis of Cumulative Impacts, by Resource Area," lists the present and reasonably foreseeable future projects that were quantitatively or qualitatively considered in this EIS. The action alternatives would not combine with any of the quantitatively assessed projects listed in Table 3-1 to have a cumulatively considerable impact on geology, geomorphology or mineral resources; therefore, this section evaluates only those projects listed in Table 3-1 that are qualitatively considered in the SLWRI.

This section provides a qualitative analysis of the overall cumulative impacts of the project alternatives combined with other past, present, and reasonably foreseeable future projects producing related impacts. For both the primary and extended study areas, a number of factors could substantially affect geology, soils and erosion, mineral resources, and geomorphology as an outcome of past, present, and future actions. Past actions that have impacted these resources include dam construction, altered flow regimes, water diversions, mining, gravel extraction, and land use impacts.

These past, present, and reasonably foreseeable actions may result in either a beneficial or adverse impact. However, there is a high level of uncertainty regarding the potential effects of the reasonably foreseeable future actions, including the Moody Flats Quarry. Therefore, geology, soils and erosion, mineral resources, and geomorphology conditions are expected to remain similar to existing conditions, with the exception of potential effects associated with future climate change and future potential development of the Moody Flats Quarry, as described below.

The effects of climate change on operations at Shasta Lake could potentially result in changes to downstream geomorphology. As described in the Climate Change Modeling Appendix, climate change could result in higher reservoir releases in the future because of an increase in winter and early-spring inflow into the lake from high-intensity storm events. The change in reservoir releases could be necessary to manage flood events resulting from these potentially larger storms. The potential increase in releases from the reservoir could lead to long-term changes in downstream channel equilibrium.

The effects of increased monthly inflow into Shasta Lake in winter and early spring could also potentially result in changes to stream channel equilibrium and geomorphology upstream from the lake and at the point where the streams meet the lake.

The effects of development of the Moody Flats Quarry, a 345-acre hardrock quarry (including a 60-acre overburden fill area), a 75-acre processing area, and a 10-acre railroad cut area would result in a loss or diminished availability of mineral resources southeast of Shasta Lake.

CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

As discussed in Section 4.3.4 above, CP1 could result in several localized project-level impacts related to (1) exposure of structures and people to geologic hazards (less than significant); (2) alteration of fluvial geomorphology and hydrology of aquatic habitats (significant but mitigable); (3) soil erosion from shoreline processes (significant and unavoidable); (4) soil erosion from upland processes (less than significant); (5) location of project features on unstable geologic or soil units (less than significant); and (6) the suitability of soils for wastewater disposal systems (less than significant). As with many types of geologic impacts, these project-level impacts are localized and would not contribute to any cumulative impacts.

Also discussed in Section 4.3.4 above, CP1 could result in regional impacts related to a diminished availability of cement, concrete sand, and aggregate and a loss of soil productivity. When taken together with reasonably foreseeable future projects in the region, CP1 could contribute to significant cumulative impacts related to these mineral and soil biomass resources. Mitigation is not available for impacts to either of these resources; therefore, CP1 would result in a cumulatively considerable incremental contribution to a significant and unavoidable cumulative impact.

As stated previously, effects of climate change on operations at Shasta Lake could include a higher frequency of high-flow events, potentially resulting in changes to geomorphology. Although implementation of CP1 could potentially diminish these effects through additional storage capacity of the reservoir available after construction, it is not expected to result in long-term changes to channel equilibrium downstream from Shasta Dam. In addition, potential impacts associated with channel meander and erosion under CP1 would be less than significant in the Shasta Lake and vicinity portion of the study area, the upper Sacramento River portion of the primary study area, and the extended study area. When added to the anticipated effects of climate change, raising Shasta Dam would not have a significant cumulative effect.

CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

As discussed in Section 4.3.4 above, CP2 could result in several localized project-level impacts related to (1) exposure of structures and people to geologic hazards (less than significant); (2) alteration of fluvial geomorphology and hydrology of aquatic habitats (significant but mitigable); (3) soil erosion from shoreline processes (significant and unavoidable); (4) soil erosion from upland processes (less than significant); (5) location of project features on unstable geologic or soil units (less than significant); and (6) the suitability of soils for wastewater disposal systems (less than significant). As with many types of geologic impacts, these project-level impacts are localized and would not contribute to any cumulative impacts.

Also discussed in Section 4.3.4 above, CP2 could result in regional impacts related to a diminished availability of cement, concrete sand, and aggregate and a loss of soil productivity. When taken together with reasonably foreseeable future projects in the region, therefore, CP2 could contribute to significant cumulative impacts related to these mineral and soil biomass resources. Mitigation is not available for impacts to either of these resources; therefore, CP2 would result in a cumulatively considerable incremental contribution to a significant and unavoidable cumulative impact.

As stated previously, effects of climate change on operations at Shasta Lake could include a higher frequency of high-flow events, potentially resulting in changes to geomorphology. Although implementation of CP2 could potentially diminish these effects through additional storage capacity of the reservoir available after construction, it is not expected to result in long-term changes to channel equilibrium downstream from Shasta Dam. In addition, potential impacts associated with channel meander and erosion under CP2 would be less than significant in the Shasta Lake and vicinity portion of the study area, the upper Sacramento River portion of the primary study area, and the extended study area. When added to the anticipated effects of climate change, raising Shasta Dam would not have a significant cumulative effect.

CP3 – 18.5-Foot Dam Raise, Agricultural Water Supply Reliability and Anadromous Fish Survival

As discussed in Section 4.3.4 above, CP3 could result in several localized project-level impacts related to (1) exposure of structures and people to geologic hazards (less than significant); (2) alteration of fluvial geomorphology and hydrology of aquatic habitats (significant but mitigable); (3) soil erosion from shoreline processes (significant and unavoidable); (4) soil erosion from upland processes (less than significant); (5) location of project features on unstable geologic or soil units (less than significant); and (6) the suitability of soils for wastewater disposal systems (less than significant). As with many types of geologic impacts, these project-level impacts are localized and would not contribute to any cumulative impacts.

Also discussed in Section 4.3.4 above, CP3 could result in regional impacts related to a diminished availability of cement, concrete sand, and aggregate and a loss of soil productivity. When taken together with reasonably foreseeable future projects in the region, therefore, CP3 could contribute to significant cumulative impacts related to these mineral and soil biomass resources. Mitigation is not available for impacts to either of these resources; therefore, CP3 would result in a cumulatively considerable incremental contribution to a significant and unavoidable cumulative impact.

As stated previously, effects of climate change on operations at Shasta Lake could include a higher frequency of high-flow events, potentially resulting in changes to geomorphology. Although implementation of CP3 could potentially diminish these effects through additional storage capacity of the reservoir available after construction, it is not expected to result in long-term changes to channel equilibrium downstream from Shasta Dam. In addition, potential impacts associated with channel meander and erosion under CP3 would be less than significant in the Shasta Lake and vicinity portion of the study area, the upper Sacramento River portion of the primary study area, and the extended study area. When added to the anticipated effects of climate change, raising Shasta Dam would not have a significant cumulative effect.

CP4 and CP4A – 18.5-Foot Dam Raise, Anadromous Fish Focus With Water Supply Reliability

As discussed in Section 4.3.4 above, CP4 or CP4A could result in several localized project-level impacts related to (1) exposure of structures and people to geologic hazards (less than significant); (2) alteration of fluvial geomorphology and hydrology of aquatic habitats (significant but mitigable); (3) soil erosion from shoreline processes (significant and unavoidable); (4) soil erosion from upland processes (less than significant); (5) location of project features on unstable geologic or soil units (less than significant); and (6) the suitability of soils for wastewater disposal systems (less than significant). As with many types of geologic impacts, these project-level impacts are localized and would not contribute to any cumulative impacts.

Also discussed in Section 4.3.4 above, CP4 or CP4A could result in regional impacts related to a diminished availability of cement, concrete sand, and aggregate and a loss of soil productivity. When taken together with reasonably foreseeable future projects in the region, therefore, CP4 or CP4A could contribute to significant cumulative impacts related to these mineral and soil biomass resources.   Mitigation is not available for either of these impacts; therefore, CP4 and CP4Awould result in a cumulatively considerable incremental contribution to a significant and unavoidable cumulative impact.

As stated previously, effects of climate change on operations at Shasta Lake could include a higher frequency of high-flow events, potentially resulting in changes to geomorphology. Although implementation of CP4 or CP4A could potentially diminish these effects through additional storage capacity of the reservoir available after construction, it is not expected to result in long-term changes to channel equilibrium downstream from Shasta Dam. In addition, potential impacts associated with channel meander and erosion under CP4 or CP4A would be less than significant in the Shasta Lake and vicinity portion of the study area, the upper Sacramento River portion of the primary study area, and the extended study area. When added to the anticipated effects of climate change, raising Shasta Dam would not have a significant cumulative effect.

CP5 – 18.5-Foot Dam Raise, Combination Plan

As discussed in Section 4.3.4 above, CP5 could result in several localized project-level impacts related to (1) exposure of structures and people to geologic hazards (less than significant); (2) alteration of fluvial geomorphology and hydrology of aquatic habitats (significant but mitigable); (3) soil erosion from shoreline processes (significant and unavoidable); (4) soil erosion from upland processes (less than significant); (5) location of project features on unstable geologic or soil units (less than significant); and (6) the suitability of soils for wastewater disposal systems (less than significant). As with many types of geologic impacts, these project-level impacts are localized and would not contribute to any cumulative impacts.

Also discussed in Section 4.3.4 above, CP5 could result in regional impacts related to a diminished availability of cement, concrete sand, and aggregate and a loss of soil productivity. When taken together with reasonably foreseeable future projects in the region, therefore, CP5 could contribute to significant cumulative impacts related to these mineral and soil biomass resources. Mitigation is not available for impacts to either of these resources; therefore, CP5 would result in a cumulatively considerable incremental contribution to a significant and unavoidable cumulative impact.

As stated previously, effects of climate change on operations at Shasta Lake could include a higher frequency of high-flow events, potentially resulting in changes to geomorphology. Although implementation of CP5 could potentially diminish these effects through additional storage capacity of the reservoir available after construction, it is not expected to result in long-term changes to channel equilibrium downstream from Shasta Dam. In addition, potential impacts associated with channel meander and erosion under CP5 would be less than significant in the Shasta Lake and vicinity portion of the study area, the upper Sacramento River portion of the primary study area, and the extended study area. When added to the anticipated effects of climate change, raising Shasta Dam would not have a significant cumulative effect.

This page left blank intentionally.

Chapter 5
Air Quality and Climate

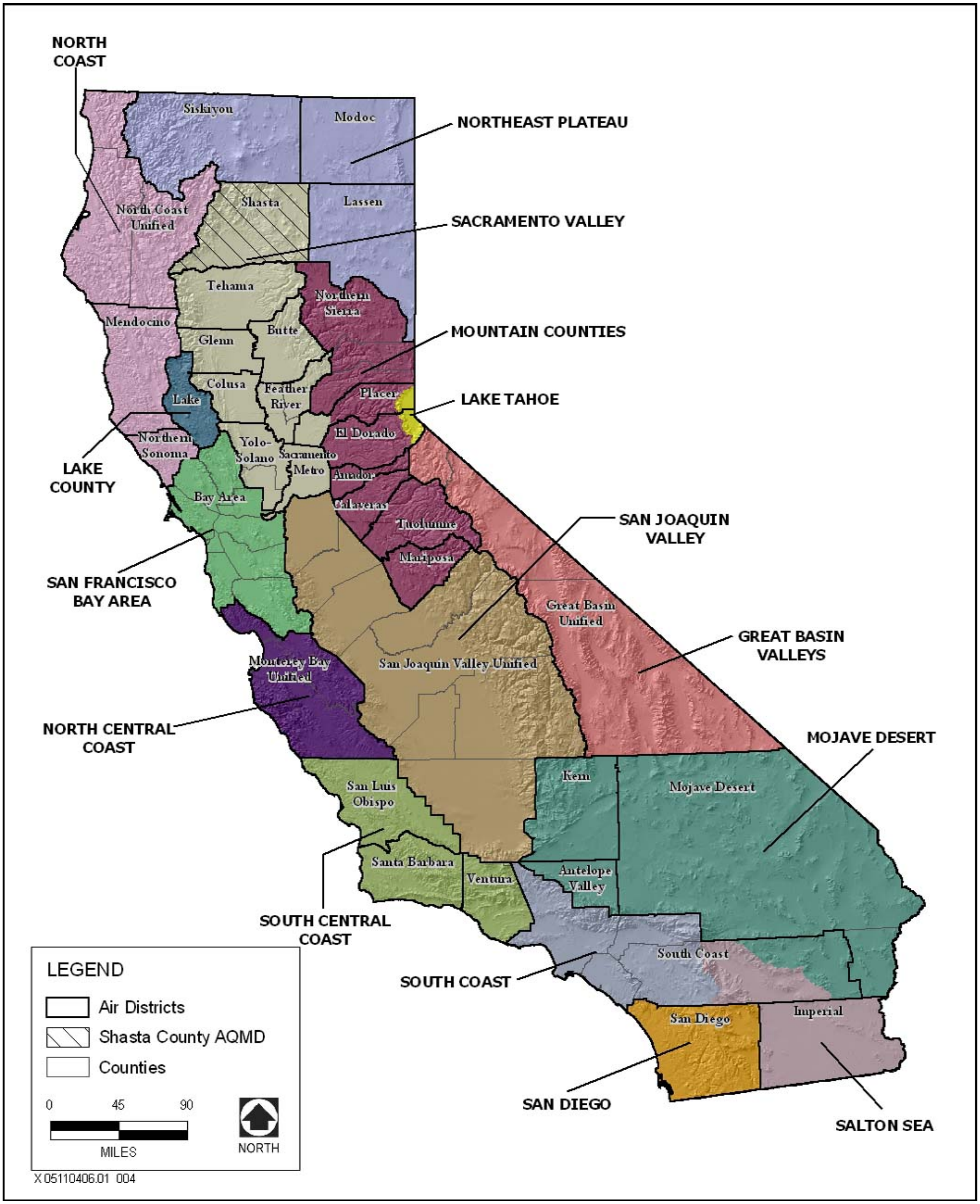
5.1 Affected Environment

This section describes existing air quality conditions in the primary study area for the dam and reservoir modifications proposed under SLWRI action alternatives. The climate and the emissions of criteria air pollutants and toxic air contaminants (TAC) at Shasta Lake and vicinity and the upper Sacramento River from Shasta Dam to Red Bluff are described. In addition, the attainment status of Shasta County relative to national and State of California (State) air quality standards is summarized.

The primary study area for air quality analysis has two components – local and regional. The local area is the area immediately surrounding Shasta Dam and Shasta Lake where project construction would occur. Regionally, Shasta and Tehama counties are located in the Northern Sacramento Valley Air Basin (NSVAB), a subarea of the Sacramento Valley Air Basin (SVAB). The SVAB also includes all of Butte, Colusa, Glenn, Sacramento, Sutter, Yolo, and Yuba counties; the western portion of Placer County; and the eastern portion of Solano County. Figure 5-1 depicts the locations of these air basins, highlighting the Shasta County Air Quality Management District (SCAQMD) area. The NSVAB includes the seven counties located in the northern portion of the Sacramento Valley: Butte, Colusa, Glenn, Shasta, Sutter, Tehama, and Yuba.

The SLWRI would not include any construction or operational activities in the extended study area (the lower Sacramento River and Delta and the CVP and SWP service areas) that would affect air quality. Therefore, this section only minimally discusses air quality conditions in the extended study area. Details about conditions in the extended study area are available in the *Air Quality and Climate Technical Report*.

This section also summarizes current climate change effects of greenhouse gas (GHG) emissions on what is referred to in this chapter as the “global study area.”



Source: ARB 2004

Figure 5-1. Air Basins in California, Including the SCAQMD Area

5.1.1 Regional Climate in the Primary Study Area

The NSVAB is bounded on the north and west sides by the Coast Ranges and on the east side by the southern portion of the Cascade Range and the northern portion of the Sierra Nevada. These mountain ranges provide a substantial physical barrier to locally created air pollution, as well as pollution transported northward on prevailing winds from the Sacramento metropolitan area (NSVPAD 2010). The valley is often subject to inversion layers that, coupled with geographic barriers and high summer temperatures, create high potential for air pollution problems.

5.1.2 Criteria Air Pollutants

Concentrations of the following air pollutants are used as indicators of ambient air quality conditions: ozone, carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), respirable and fine particulate matter (PM_{10} and $PM_{2.5}$), and lead. Because these are the most prevalent air pollutants known to be deleterious to human health, they are commonly referred to as “criteria air pollutants.”

Each criteria air pollutant is described briefly below. A more in-depth discussion is provided in the *Air Quality and Climate Technical Report*.

Ozone

Ozone is a photochemical oxidant and the primary component of smog. Ozone is not directly emitted into the air, but is formed through complex chemical reactions between precursor emissions of reactive organic gases (ROG) and oxides of nitrogen (NO_X) in the presence of sunlight. ROG are volatile organic compounds (VOC). ROG emissions result primarily from incomplete combustion and the evaporation of chemical solvents and fuels. NO_X are a group of gaseous compounds of nitrogen and oxygen that results from the combustion of fuels.

Ozone located in the lower atmosphere is a major health and environmental concern. Meteorology and terrain play a major role in ozone formation. Low wind speeds or stagnant air coupled with warm temperatures and clear skies provide the optimum conditions for ozone formation. Therefore, summer is the peak ozone season. Ozone is a regional pollutant that often affects large areas. Ozone concentrations over or near urban and rural areas reflect an interplay of emissions of ozone precursors, transport, meteorology, and atmospheric chemistry (Godish 2004).

Carbon Monoxide

CO is a colorless, odorless, and poisonous gas produced by incomplete burning of carbon in fuels, primarily from mobile (transportation) sources. Approximately 77 percent of the nation’s CO emissions are from mobile sources. The other 23 percent consist of CO emissions from wood-burning stoves, incinerators, and industrial sources. The highest concentrations are generally associated with cold, stagnant weather conditions that occur during winter. In contrast to ozone, which is a regional pollutant, CO causes problems on a local scale.

Nitrogen Dioxide

NO_2 is a brownish, highly reactive gas that is present in all urban environments. The major human-made sources of NO_2 are combustion devices, such as boilers, gas turbines, and mobile and stationary combustion engines. NO_2 forms quickly from emissions from cars, trucks and buses, power plants, and off-road equipment. In addition to contributing to the formation of ground-level ozone and fine particle pollution, NO_2 is linked with a number of adverse effects on the respiratory system (EPA 2010a). The combined emissions of NO and NO_2 are referred to as NO_X, which are reported as equivalent NO_2. Because NO_2 is formed and depleted by reactions associated with ozone, the NO_2 concentration in a particular geographical area may not be representative of the local NO_X emission sources.

Sulfur Dioxide

SO_2 is produced by such stationary sources as coal and oil combustion, steel mills, refineries, and pulp and paper mills. SO_2 is a respiratory irritant. On contact with the moist mucous membranes, SO_2 produces sulfurous acid.

Particulate Matter

Respirable particulate matter with an aerodynamic diameter of 10 micrometers or less is referred to as PM_{10}. PM_{10} consists of particulate matter emitted directly into the air, such as fugitive dust, soot, and smoke from mobile and stationary sources, construction operations, fires, and natural windblown dust, and particulate matter formed in the atmosphere by condensation and/or transformation of SO_2 and ROG. $PM_{2.5}$ includes a subgroup of finer particles that have an aerodynamic diameter of 2.5 micrometers or less (EPA 2011a).

Lead

Lead is a metal found naturally in the environment and in manufactured products. The major sources of lead emissions have historically been mobile and industrial sources. As a result of the phase-out of leaded gasoline, metal processing is currently the primary source of lead emissions. The highest levels of lead in air are generally found near lead smelters. Other stationary sources are waste incinerators, utilities, and lead-acid battery manufacturers.

5.1.3 Monitoring Station Data and Criteria Pollutant Attainment Area Designations

Shasta Lake and Vicinity and Upper Sacramento River (Shasta Dam to Red Bluff)

Concentrations of criteria air pollutants are measured at several monitoring stations in Shasta County. The monitoring stations in the City of Shasta Lake and at the Redding Health Department are the closest stations to the project construction area with recent data for ozone and particulate matter. In general, the ambient air quality measurements from these stations are representative of the study area's air quality. Table 5-1 summarizes the air quality data from the most recent 3 years. The data are compared with the ambient air quality standards as noted below. Refer to Table 5-2 for a full listing of all ambient all quality standards.

Table 5-1. Summary of Annual Ambient Air Quality Data (2011 – 2013)

	2011	2012	2013
Ozone			
City of Shasta Lake, Lake Boulevard			
California maximum concentration (1-hour/8-hour average, ppm)	0.083/0.076	0.078/0.068	0.078/0.071
Number of days State 1-hour/8-hour standard exceeded	0/5	0/0	0/1
Number of days national 1-hour/8-hour standard exceeded	0/1	0/0	0/0
Redding Health Department Monitoring Station			
California maximum concentration (1-hour/8-hour average, ppm)	0.073/0.064	0.082/0.061	0.078/0.052
Number of days State 1-hour/8-hour standard exceeded	0/0	0/0	0/0
Number of days national 1-hour/8-hour standard exceeded	0/0	0/0	0/0
Fine Particulate Matter ($PM_{2.5}$)			
Redding Health Department Monitoring Station			
California maximum concentration (µg/m^3)	18.8	26.4	17.6
Number of days national standard exceeded (measured[a])	0	0	0
Respirable Particulate Matter (PM_{10})			
City of Shasta Lake, La Mesa Avenue			
Maximum concentration (µg/m^3)	28.8	37.3	45.5
Number of days State standard exceeded (measured/calculated[a])	0/0.0	0/*	0/0.0
Number of days national standard exceeded (measured/calculated[a])	0/0.0	0/*	0/0.0

Table 5-1. Summary of Annual Ambient Air Quality Data (2011 – 2013) (contd.)

	2011	2012	2013
Redding Health Department Monitoring Station			
Maximum concentration ($\mu g/m^3$)	34.9	34.8	29.5
Number of days State standard exceeded (measured/calculated)[1]	0/0.0	0/*	0/*
Number of days national standard exceeded (measured/calculated)[1]	0/0.0	0/0.0	0/0.0

Source: ARB 2014

Note:
[1] Measured days are those days that an actual measurement was greater than the level of the State daily standard or the national daily standard. Measurements are typically collected every 6 days. Calculated days are the estimated number of days that a measurement would have been greater than the level of the standard had measurements been collected every day. The number of days above the standard is not necessarily the number of violations of the standard for the year.

Key:
* = insufficient data available to determine value.
$\mu g/m^3$ = micrograms per cubic meter
$PM_{2.5}$ = fine particulate matter with an aerodynamic diameter of 2.5 micrometers or less
PM_{10} = respirable particulate matter with an aerodynamic diameter of 10 micrometers or less
ppm = parts per million

Table 5-2. Ambient Air Quality Standards and Designations

Pollutant	Averaging Time	California		National Standards [1]		
		Standards [2,3]	Attainment Status (Shasta County) [4]	Primary [3,5]	Secondary [3,6]	Attainment Status (Shasta County) [7]
Ozone	1-hour	0.09 ppm (180 μg/m^3)	N (Moderate)	*Note 8*	Same as primary standard	–
	8-hour	0.070 ppm	–	0.075 ppm (147 μg/m^3)		U/A
Carbon monoxide(CO)	1-hour	20 ppm (23 mg/m^3)	U	35 ppm (40 mg/m^3)	–	U/A
	8-hour	9 ppm (10 mg/m^3)		9 ppm (10 mg/m^3)		
	8-hour (Lake Tahoe)	6 ppm (7 mg/m^3)	–	–	–	–
Nitrogen dioxide (NO_2)	Annual Arithmetic Mean	0.030 ppm (57 μg/m^3)	–	0.053 ppm (100 μg/m^3) [9]	Same as primary standard	U/A
	1-hour	0.18 ppm (339 μg/m^3)	A	0.100 ppm (188 μg/m^3) [9]		–
Sulfur dioxide (SO_2)	24-hour	0.04 ppm (105 μg/m^3)	A	–	–	U
	3-hour	–	–	–	0.5 ppm (1300 μg/m^3) [9]	
	1-hour	0.25 ppm (655 μg/m^3)	A	0.075 ppm (196 μg/m^3) [10]	–	–
Respirable particulate matter (PM_{10})	Annual Arithmetic Mean	20 μg/m^3	N	–	Same as primary standard	U/A
	24-hour	50 μg/m^3		150 μg/m^3 [6]		
Fine particulate matter ($PM_{2.5}$)	Annual Arithmetic Mean	12 μg/m^3	U	15 μg/m^3	Same as primary standard	U/A
	24-hour	–	–	35 μg/m^3		
Lead [11]	30-day Average	1.5 μg/m^3	A	–	–	–
	Calendar Quarter	–		1.5 μg/m^3	Same as primary standard	A
	Rolling 3 Month Average	–		0.15 μg/m^3		
Sulfates	24-hour	25 μg/m^3	A	No national standards		
Hydrogen sulfide	1-hour	0.03 ppm (42 μg/m^3)	U			
Vinyl chloride [11]	24-hour	0.01 ppm (26 μg/m^3)	U/A			
Visibility-reducing particle matter	8-hour	Extinction coefficient of 0.23 per kilometer—visibility of 10 mi or more	U			

Table 5-2. Ambient Air Quality Standards and Designations (contd.)

Sources: ARB 2010a, 2010b; EPA 2011b

Notes:

[1] National standards (other than ozone, particulate matter, and those based on annual averages or annual arithmetic means) are not to be exceeded more than once a year. The ozone standard is attained when the fourth highest 8-hour concentration in a year, averaged over 3 years, is equal to or less than the standard. The PM10 24-hour standard is attained when 99 percent of the daily concentrations, averaged over 3 years, are equal to or less than the standard. The PM2.5 24-hour standard is attained when 98 percent of the daily concentrations, averaged over 3 years, are equal to or less than the standard. Contact the U.S. Environmental Protection Agency (EPA) for further clarification and current Federal policies.

[2] California standards for ozone, CO (except Lake Tahoe), SO_2 (1- and 24-hour), NO_2, particulate matter, and visibility-reducing particles are values that are not to be exceeded. All others are not to be equaled or exceeded. California ambient air quality standards are listed in the Table of Standards in Section 70200 of Title 17 of the California Code of Regulations.

[3] Concentration expressed first in units in which it was promulgated (i.e., parts per million (ppm) or micrograms per cubic meter ($\mu g/m^3$)). Equivalent units given in parentheses are based upon a reference temperature of 25 degrees Celsius (°C) and a reference pressure of 760 torr. Most measurements of air quality are to be corrected to a reference temperature of 25°C and a reference pressure of 760 torr; ppm in this table refers to ppm by volume, or micromoles of pollutant per mole of gas.

[4] Unclassified (U): A pollutant is designated unclassified if the data are incomplete and do not support a designation of attainment or nonattainment.

Attainment (A): A pollutant is designated attainment if the State standard for that pollutant was not violated at any site in the area during a 3-year period.

Nonattainment (N): A pollutant is designated nonattainment if there was a least one violation of a State standard for that pollutant in the area.

Nonattainment/Transitional (NT): A subcategory of the nonattainment designation. An area is designated nonattainment/transitional to signify that the area is close to attaining the standard for that pollutant.

[5] National Primary Standards: The levels of air quality necessary, with an adequate margin of safety, to protect the public health.

[6] National Secondary Standards: The levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant.

[7] Nonattainment (N): Any area that does not meet (or that contributes to ambient air quality in a nearby area that does not meet) the national primary or secondary ambient air quality standard for the pollutant. Attainment (A): Any area that meets the national primary or secondary ambient air quality standard for the pollutant.

Unclassifiable (U): Any area that cannot be classified on the basis of available information as meeting or not meeting the national primary or secondary ambient air quality standard for the pollutant.

[8] The 1-hour ozone national ambient air quality standard was revoked on June 15, 2005, for all areas in California.

[9] To attain this standard, the 3-year average of the 98th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 0.100 part per million (ppm) (effective January 22, 2010). Note that the EPA standards are in units of parts per billion (ppb). California standards are in units of ppm. To directly compare the national standards to the California standards, the units can be converted from ppb to ppm. In this case, the national standards of 53 ppb and 100 ppb are identical to 0.053 ppm and 0.100 ppm, respectively.

[10] On June 2, 2010, EPA established a new 1-hour SO_2 standard, effective August 23, 2010, which is based on the 3-year average of the annual 99th percentile of 1-hour daily maximum concentrations. EPA also proposed a new automated Federal Reference Method (FRM) using ultraviolet technology, but will retain the older pararosaniline methods until the new FRM have adequately permeated State monitoring networks. EPA also revoked both the existing 24-hour SO_2 standard of 0.14 ppm and the annual primary SO_2 standard of 0.030 ppm, effective August 23, 2010. The secondary SO_2 standard was not revised at that time; however, the secondary standard is undergoing a separate review by EPA. Note that the new standard is in ppb. California standards are in ppm. To directly compare the new primary national standard to the California standard the units can be converted to ppm. In this case, the national standard of 75 ppb is identical to 0.075 ppm.

[11] The California Air Resources Board has identified lead and vinyl chloride as toxic air contaminants with no threshold of exposure for adverse health effects determined. These actions allow for the implementation of control measures at levels below the ambient concentrations specified for these pollutants.

Key:

$\mu g/m^3$ = micrograms per cubic meter

mg/m^3 = milligrams per cubic meter

mi = miles

ppm = parts per million

The monitoring data are used to designate areas according to their attainment status for criteria air pollutants. The purpose of these designations is to identify those areas with air quality problems and thereby initiate planning efforts for improvement. The three basic designation categories are “nonattainment,” “attainment,” and “unclassified” (see notes in Table 5-2 for full definitions). “Unclassified” is used in an area that cannot be classified on the basis of available information as meeting or not meeting the standards. In addition, the California designations include a subcategory of the nonattainment designation, “nonattainment-transitional,” that is given to nonattainment areas that are progressing and nearing attainment. The most current attainment designations for Shasta County are shown in Table 5-2 for each criteria air pollutant.

Lower Sacramento River and Delta

The lower Sacramento River and Delta areas are within the SVAB and the San Joaquin Valley Air Basin. As described in greater detail in the *Air Quality and Climate Technical Report*, these basins are Federal and State nonattainment areas for ozone, PM_{10}, and $PM_{2.5}$.

CVP/SWP Service Areas

The CVP and SWP service areas extend beyond the Central Valley into the San Francisco Bay Area, North Central Coast, South Central Coast, and Mountain Counties air basins. Federal and State ozone attainment designations for all California counties and air basins are provided in the *Air Quality and Climate Technical Report*. All counties in California south of Shasta County, with the exception of Lake, Sonoma, Tuolumne, and Mariposa counties, are State nonattainment areas for PM_{10} (ARB 2010a).

5.1.4 Toxic Air Contaminants in the Primary Study Area

TACs, or in Federal terms hazardous air pollutants (HAP), are air pollutants that may cause or contribute to an increase in mortality or in serious illness, or that may pose a hazard to human health. TACs are usually present in minute quantities in the ambient air; however, their high toxicity or health risk may pose a threat to public health even at low concentrations. Of the TACs for which data are available in California, diesel particulate matter (diesel PM), naturally occurring asbestos, benzene, 1,3-butadiene, acetaldehyde, carbon tetrachloride, hexavalent chromium, para-dichlorobenzene, formaldehyde, methylene chloride, and perchloroethylene pose the greatest known health risks. Dioxins are also considered to pose substantial health risk and diesel PM poses the greatest health risk. Current facilities permitted by SCAQMD in the project vicinity are Lehigh Southwest Cement Company, Mountain Gate Quarry, Knauf Insulation, and Sierra Pacific Industries.

5.1.5 Global Study Area

Atmospheric GHGs play a critical role in determining the earth’s surface temperature. Solar radiation enters the earth’s atmosphere from space. Prominent GHGs contributing to the greenhouse effect are carbon dioxide (CO_2), methane, nitrous oxide, hydrofluorocarbons, chlorofluorocarbons, and sulfur hexafluoride. Sources of GHG emissions associated with existing operations include vehicles used for operation and maintenance of the dam and recreation areas, vehicles used by recreational visitors, and fossil fuel-powered boats on Shasta Lake. Human-caused emissions of these GHGs that exceed natural ambient concentrations are responsible for intensifying the greenhouse effect and have led to a trend of unnatural warming of the earth's climate, known as global climate change or global warming (Ahrens 2003).

To provide a method of quantifying GHG emissions, the standard unit of CO_2e, or CO_2 equivalent, was developed. The definition of CO_2e is "The quantity of a given GHG multiplied by its total global warming potential (GWP). This is the standard unit for comparing the degree of warming that can be caused by GHGs" (CCAR 2009). The GWP of a GHG is dependent on the lifetime, or persistence, of the gas molecule in the atmosphere compared to CO_2. The GWP of methane is 23; the GWP of nitrous oxide is 296. Therefore, methane and nitrous oxide are more potent GHGs than CO_2. Expressing emissions in CO_2e takes the contributions of all GHG emissions to the greenhouse effect and converts them to a single unit equivalent to the effect that would occur if only CO_2 were being emitted. The most common quantity unit for CO_2e is million metric tons (MMT).

Climate change is a global phenomenon. GHGs are global pollutants, unlike criteria air pollutants and TACs, which are pollutants of regional and local concern. Whereas pollutants with localized air quality effects have relatively short atmospheric lifetimes (about 1 day), GHGs have long atmospheric lifetimes (1 year to several thousand years). GHGs persist in the atmosphere for long enough time periods to be dispersed around the globe. Although the exact lifetime of any particular GHG molecule is dependent on multiple variables and cannot be pinpointed, it is understood that more CO_2 is emitted into the atmosphere than is sequestered by ocean uptake, vegetation, and other forms of sequestration. Of the total annual human-caused CO_2 emissions, approximately 54 percent is sequestered through ocean uptake, uptake by Northern Hemisphere forest regrowth, and other terrestrial sinks within a year, whereas the remaining 46 percent of human-caused CO_2 emissions remains stored in the atmosphere (Seinfeld and Pandis 1998).

Effects of GHGs are borne globally, as opposed to localized air quality effects of criteria air pollutants and TACs. The quantity of GHGs that it takes to ultimately result in climate change is not precisely known; suffice it to say that the quantity is enormous, and no single project alone would be expected to measurably contribute to a noticeable incremental change in the global average temperature, or to global, local, or micro climate. From the standpoint of CEQA, GHG effects related to global climate change are inherently cumulative.

Please see the *Air Quality and Climate Technical Report* for a discussion of GHG feedback mechanisms and uncertainty.

5.1.6 Existing Sensitive Receptors

Sensitive receptors are more susceptible to the effects of air pollution than the general population. They are typically defined as "facilities that house or attract children, the elderly, people with illnesses, or others who are especially sensitive to the effects of air pollutants," such as hospitals, schools, convalescent facilities, and residential areas.

No sensitive receptors are immediately adjacent to (within 0.5 mile of) the dam. The nearest occupied residence is the horse camp located approximately 7,000 feet downstream; residences on Lake Boulevard are located approximately 4,500 feet east. Other sensitive receptors would include any residences within 0.5 mile of other construction work being done as a result of the dam raise. Bridge construction would occur at Charlie Creek, Doney Creek, McCloud River, Pit River, Fenders Ferry, Didallas Creek, and other Union Pacific Railroad bridges. Major road construction would occur on Lakeshore Drive, in the Turntable Bay Area, on Gillman Road, in Jones Valley and the Silverthorn Area, and on Salt Creek Road. The school nearest to construction activities would be the Smithson School in Lakehead (approximately 500 feet); the nearest place of worship would be Canyon Community Church, also in Lakehead (approximately 800 feet).

5.2 Regulatory Framework

Air quality in Shasta County is regulated by such agencies as the U.S. Environmental Protection Agency (EPA), the California Air Resources Board (ARB), and SCAQMD. Each of these agencies develops rules, regulations, policies, and/or goals to comply with applicable legislation. Although EPA regulations may not be superseded, both State and local regulations may be more stringent.

5.2.1 Federal

Criteria Air Pollutants

At the Federal level, EPA implements national air quality programs. EPA's air quality mandates are drawn primarily from the Federal Clean Air Act (CAA), which was enacted in 1970 and most recently amended in 1990.

The CAA required EPA to establish primary and secondary national ambient air quality standards, as shown in Table 5-2. The CAA also required each state to prepare an air quality control plan referred to as a State implementation plan (SIP). The Federal Clean Air Act Amendments of 1990 (CAAA) added requirements for states with nonattainment areas to revise their SIPs to incorporate additional control measures to reduce air pollution. The SIP is modified periodically to reflect the latest emissions inventories, planning documents, and rules and regulations of the air basins as reported by their jurisdictional agencies. EPA reviews all SIPs to determine whether they conform to the mandates of CAA and its amendments, and whether implementation will achieve air quality goals. If EPA determines a SIP to be inadequate, a Federal implementation plan that imposes additional control measures may be prepared for the nonattainment area. Failure to submit an approvable SIP or to implement the plan within the mandated time frame may result in the application of sanctions to transportation funding and stationary air pollution sources in the air basin.

Hazardous Air Pollutants

Air quality regulations also focus on TACs, or in Federal parlance, HAPs. In general, for those TACs that may cause cancer, there is no concentration that does not present some risk. In other words, there is no threshold level below which adverse health effects may not be expected to occur. This contrasts with the criteria air pollutants, for which acceptable levels of exposure can be determined and for which the ambient standards have been established (Table 5-2). Instead, EPA and ARB regulate HAPs and TACs, respectively, through statutes and regulations that generally require the use of the maximum available control technology or best available control technology for toxics to limit emissions. These statutes and regulations establish the regulatory framework for TACs.

EPA has programs for identifying and regulating HAPs. Title III of the CAAA directed EPA to promulgate national emissions standards for HAPs. National emissions standards for HAPs vary depending on the pollutant source type. The national emissions standards for HAPs for major stationary sources of HAPs could therefore be different than those for area sources. Major sources are defined as stationary sources with potential to emit more than 10 tons per year of any HAP or more than 25 tons per year of any combination of HAPs; all other sources are considered area sources. The emissions standards were to be promulgated in two phases. In the first phase (1992 to 2000), EPA developed technology-based emission standards designed to produce the maximum emission reduction achievable. These standards are generally referred to as requiring maximum available control technology. For area sources, the standards may be different, based on generally available control technology. In the second phase (2001 to 2008), EPA was required to promulgate health risk-based emissions standards, where deemed necessary, to address risks remaining after implementation of the technology-based national emission standards for HAPs.

The CAAA also required EPA to promulgate vehicle or fuel standards containing reasonable requirements that control toxic emissions of benzene and formaldehyde at a minimum. Performance criteria were established to limit mobile-source emissions of toxics, including benzene, formaldehyde, and 1,3-butadiene. In addition, Section 219 required the use of reformulated gasoline in selected areas with the most severe ozone nonattainment conditions to further reduce mobile-source emissions.

General Conformity

The 1990 amendments to CAA Section 176 require EPA to promulgate rules to ensure that Federal actions conform to the appropriate SIP. These rules are known as the General Conformity Rule (40 Code of Federal Regulations Parts 51.850–51.860 and 93.150–93.160). Any Federal agency responsible for an action in a nonattainment/maintenance area must determine whether that action conforms to the applicable SIP or is exempt from General Conformity Rule requirements.

Shasta County, where the proposed action would occur, is neither a nonattainment area nor a maintenance area for the national ambient air quality standards. Therefore, the General Conformity Rule is not applicable to the project.

Greenhouse Gases

Mandatory Greenhouse Gas Reporting Rule On September 22, 2009, EPA released its final Greenhouse Gas Reporting Rule (Reporting Rule). The Reporting Rule is a response to the fiscal year 2008 Consolidated Appropriations Act (House Bill 2764; Public Law 110-161), which required EPA to develop "…mandatory reporting of greenhouse gases above appropriate thresholds in all sectors of the economy…" The Reporting Rule applies to most entities that emit 25,000 metric tons (MT) CO_2e or more per year. Since 2010, facility owners have been required to submit an annual GHG emissions report with detailed calculations of facility GHG emissions. The Reporting Rule also mandates recordkeeping and administrative requirements for EPA to verify annual GHG emissions reports.

U.S. Environmental Protection Agency Endangerment and Cause or Contribute Findings On December 7, 2009, the EPA Administrator signed two distinct findings regarding GHGs under Section 202(a) of the CAA:

- **Endangerment Finding –** The current and projected concentrations of the six key well-mixed GHGs – CO_2, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride – in the atmosphere threaten the public health and welfare of current and future generations.

- **Cause or Contribute Finding –** The combined emissions of these well-mixed GHGs from new motor vehicles and new motor vehicle engines contribute to GHG pollution, which threatens public health and welfare.

Council on Environmental Quality Draft NEPA Guidelines Because of uneven treatment of climate change under NEPA, the International Center for Technology Assessment, Natural Resources Defense Council, and Sierra Club filed a petition with the Council on Environmental Quality (CEQ) in March 2008. The petition requested that climate change analyses be included in all

Federal environmental review documents. In October 2009, President Barack Obama signed Executive Order 13514, “Federal Leadership in Environmental, Energy, and Economic Performance.” The goal of this executive order is “to establish an integrated strategy towards sustainability in the Federal Government and to make reduction of GHGs a priority for Federal agencies” (FedCenter 2011).

In response to the petition and subsequent Executive Order 13514, CEQ issued guidance on including GHG emissions and climate change impacts in environmental review documents under NEPA. CEQ’s guidance (issued February 18, 2010) suggests that Federal agencies consider opportunities to reduce GHG emissions caused by proposed Federal actions, adapt their actions to climate change impacts throughout the NEPA process, and address these issues in the agencies’ NEPA procedures. The following are the two main factors to consider when addressing climate change in environmental documentation:

- The effects of a proposed action and alternative actions on GHG emissions
- The impacts of climate change on a proposed action or alternatives

CEQ notes that “significant” national policy decisions with “substantial” GHG impacts require analysis of their GHG effects. That is, the GHG effects of a Federal agency’s proposed action must be analyzed if the action would cause “substantial” annual direct emissions; would implement energy conservation or reduced energy use or GHG emissions; or would promote cleaner, more efficient renewable-energy technologies. Qualitative or quantitative information on GHG emissions that is useful and relevant to the decision should be used when deciding among alternatives.

CEQ states that if a proposed action would cause direct annual emissions of more than 25,000 MT CO_2e, a quantitative and qualitative assessment may be meaningful to decision makers and the public. If annual direct emissions would be less than 25,000 MT CO_2e, Federal agencies are encouraged to consider whether the action’s long-term emissions should receive similar analysis.

Greenhouse Gas Permitting Requirements on Large Industrial Facilities
New major stationary emissions sources and major modifications at existing stationary sources are required by the CAA to obtain an air pollution permit before commencing construction. On May 13, 2010, EPA issued the Prevention of Significant Deterioration and Title V Greenhouse Gas Tailor Rule (EPA 2011). This final rule sets thresholds for GHG emissions that define when permits under the New Source Review Prevention of Significant Deterioration (PSD) and Title V Operating Permit programs are required for new and existing industrial facilities.

PSD permitting requirements now cover new construction projects that emit GHG emissions of at least 100,000 tons (90,718 MT) per year even if they do not exceed the permitting thresholds for any other pollutant. Modifications at existing facilities that increase GHG emissions by at least 75,000 tons (68,039 MT) per year will be subject to permitting requirements, even if they do not significantly increase emissions of any other pollutant. Title V Operating Permit requirements apply to sources based on their GHG emissions even if they would not apply based on emissions of any other pollutant. Facilities that emit at least 100,000 tons (90,718 MT) per year of CO_2e will be subject to Title V permitting requirements.

5.2.2 State

ARB coordinates and oversees State and local air pollution control programs in California and implements the California Clean Air Act (CCAA).

Criteria Air Pollutants

The CCAA, which was adopted in 1988, required ARB to establish California ambient air quality standards (Table 5-2). The CCAA requires that all local air districts in the state endeavor to achieve and maintain California ambient air quality standards by the earliest practical date. The act specifies that local air districts should particularly focus on reducing emissions from transportation and area-wide sources, and authorizes districts to regulate indirect sources. Among ARB's other responsibilities are to oversee local air district compliance with California and Federal laws; approve local air quality plans; submit SIPs to EPA; monitor air quality; determine and update area designations and maps; and set emissions standards for new mobile sources, consumer products, small utility engines, off-road vehicles, and fuels.

Toxic Air Contaminants

TACs in California are regulated primarily through the Tanner Air Toxics Act (Assembly Bill (AB) 1807 (Statutes of 1983)) and the Air Toxics Hot Spots Information and Assessment Act (AB 2588 (Statutes of 1987)). AB 1807 sets forth a formal procedure for ARB to designate substances as TACs. Research, public participation, and scientific peer review must be completed before ARB can designate a substance as a TAC. To date, ARB has identified more than 21 TACs and has adopted EPA's list of HAPs as TACs, including diesel PM.

Once a TAC is identified, ARB adopts an airborne toxics control measure for sources that emit that particular TAC. If a safe threshold exists for a substance at which there is no toxic effect, the control measure must reduce exposure below that threshold. If there is no safe threshold, the measure must incorporate best available control technology to minimize emissions.

AB 2588 requires facilities that emit toxic substances above a specified level to do all of the following:

- Prepare a toxic emissions inventory

- Prepare a risk assessment if emissions are significant
- Notify the public of significant risk levels
- Prepare and implement risk reduction measures

Greenhouse Gases

Various statewide initiatives to reduce California's contribution to GHG emissions have raised awareness that, even though the various contributors to and consequences of global climate change are not yet fully understood, global climate change is under way, and real potential exists for severe adverse environmental, social, and economic effects in the long term. The most relevant laws and orders are discussed in more detail below.

California Environmental Quality Act and SB 97 CEQA requires lead agencies to consider the reasonably foreseeable adverse environmental effects of projects they are considering for approval. GHG emissions have the potential to adversely affect the environment because they contribute to global climate change. In turn, global climate change has the potential to raise sea levels, affect rainfall and snowfall, and affect habitat.

Senate Bill 97 Senate Bill (SB) 97 was enacted in August 2007 as part of the State budget negotiations and is codified in Section 21083.05 of the California Public Resources Code. SB 97 directs the Governor's Office of Planning and Research (OPR) to propose guidance in the State CEQA Guidelines "for the mitigation of GHG emissions or the effects of GHG emissions." SB 97 directed OPR to develop text for the State CEQA Guidelines by July 2009. This legislation also directed the State Resources Agency (now known as the California Natural Resources Agency (Resources Agency)) – the agency charged with adopting the State CEQA Guidelines – to certify and adopt such guidelines by January 2010. In April 2009, OPR prepared draft CEQA Guidelines amendments and submitted them to the Resources Agency (see below). On July 3, 2009, the Resources Agency began the rulemaking process established under the Administrative Procedure Act.

The Resources Agency recommended amendments for GHGs to fit within the existing CEQA framework for environmental analysis, which calls for lead agencies to determine baseline conditions and levels of significance and evaluate mitigation measures. The amendments to the State CEQA Guidelines do not identify a threshold of significance for GHG emissions, nor do they prescribe assessment methodologies or specific mitigation measures. The amendments encourage lead agencies to consider many factors in performing a CEQA analysis, but preserve the discretion that CEQA grants lead agencies to make their own determinations based on substantial evidence.

Section 15064.4, "Determining the Significance of Impacts from Greenhouse Gas Emissions," of the State CEQA Guidelines encourages lead agencies to consider three factors to assess the significance of GHG emissions:

1. Will the project increase or reduce GHGs as compared to the baseline?

2. Will the project's GHG emissions exceed the lead agency's threshold of significance?

3. Does the project comply with regulations or requirements to implement a statewide, regional, or local GHG reduction or mitigation plan?

These questions are addressed in Section 5.3.

Section 15064.4 also recommends that lead agencies make a good-faith effort, based on available information, to describe, calculate, or estimate the amount of GHG emissions associated with a project.

Section 15126.4, "Consideration and Discussion of Mitigation Measures Proposed to Minimize Significant Effects," of the State CEQA Guidelines lists considerations for lead agencies related to feasible mitigation measures to reduce GHG emissions. Among those considerations are the following:

- Project features, project design, or other measures that are incorporated into the project to substantially reduce energy consumption or GHG emissions

- Compliance with the requirements in a previously approved plan or mitigation program to reduce or sequester GHG emissions, when the plan or program provides specific requirements that will avoid or substantially lessen the potential impacts of the project

- Measures that sequester carbon or carbon-equivalent emissions

Section 15126.4 also specifies that where mitigation measures are proposed to reduce GHG emissions through off-site actions or purchase of carbon offsets, these mitigation measures must be part of a reasonable plan of mitigation that the relevant agency commits itself to implementing.

In addition, as part of the amendments and additions to the State CEQA Guidelines, a new set of environmental checklist questions (VII. Greenhouse Gas Emissions) was added to Appendix G of the State CEQA Guidelines. The new set asks whether a project would do either of the following:

a) Generate GHG emissions, either directly or indirectly, that may have a significant impact on the environment?

b) Conflict with any applicable plan, policy or regulation of an agency adopted for the purpose of reducing the emissions of GHGs?

Preliminary Draft Staff Proposal: Recommended Approaches for Setting Interim Significance Thresholds for Greenhouse Gases Under CEQA CEQA gives discretion to lead agencies to establish thresholds of significance based on individual circumstances. To assist in that exercise, and because OPR believes the unique nature of GHGs warrants investigation of a statewide threshold of significance for GHG emissions, OPR asked ARB technical staff to recommend a methodology for setting thresholds of significance. In October 2008, ARB released *Preliminary Draft Staff Proposal: Recommended Approaches for Setting Interim Significance Thresholds for Greenhouse Gases under the California Environmental Quality Act* (ARB 2008). This draft proposal included a conceptual approach for thresholds associated with industrial, commercial, and residential projects. For nonindustrial projects, the steps to presuming a less than significant climate change impact generally involve analyzing whether the project meets the following criteria (ARB 2008):

- Is exempt under existing statutory or categorical exemptions
- Complies with a previously approved plan or target
- Meets specified minimum performance standards
- Falls below an as-yet-unspecified annual emissions level

The performance standards focus on construction activities, energy and water consumption, generation of solid waste, and transportation. For industrial projects, the draft proposal recommends a tiered analysis procedure similar to the procedure for analyzing nonindustrial projects. However, for industrial projects a quantitative limit for less than significant impacts is established at approximately 7,000 MT CO_2e per year. These standards have not yet been adopted or finalized as a basis for evaluating the significance of a project's contribution to climate change.

Overall, as directed by SB 97, the Resources Agency adopted Amendments to the CEQA Guidelines for GHGs emissions on December 30, 2009. On February 16, 2010, the Office of Administrative Law approved the Amendments, and filed them with the Secretary of State for inclusion in the California Code of Regulations. The Amendments became effective on March 18, 2010.

Executive Order S-3-05 Executive Order S-3-05 made California the first state to formally establish GHG emissions reduction goals. Executive Order S-3-05 includes the following GHG emissions reduction targets for California:

- By 2010, reduce GHG emissions to 2000 levels.

- By 2020, reduce GHG emissions to 1990 levels.
- By 2050, reduce GHG emissions to 80 percent below 1990 levels.

The final emission target of 80 percent below 1990 levels would put the state's emissions in line with estimates of the required worldwide reductions needed to bring about long-term climate stabilization and avoidance of the most severe impacts of climate change (IPCC 2007).

Executive Order S-3-05 also dictated that the Secretary of the California Environmental Protection Agency coordinate oversight of efforts to meet these targets with all of the following:

- The Secretaries of the Business, Transportation, and Housing Agency; California Department of Food and Agriculture; and Resources Agency
- The Chairpersons of ARB and the California Energy Commission
- The President of the California Public Utilities Commission

This group was subsequently named the Climate Action Team.

As laid out in Executive Order S-3-05, the Climate Action Team has submitted biannual reports to the Governor and State legislature describing progress made toward reaching the targets. The Climate Action Team is finalizing its second biannual report on the effects of climate change on California's resources.

Assembly Bill 32 In 2006, California passed the California Global Warming Solutions Act of 2006 (AB 32; California Health and Safety Code, Sections 38500 et seq.). AB 32 further details and puts into law the midterm GHG reduction target established in Executive Order S-3-05 – reduce GHG emissions to 1990 levels by 2020. AB 32 also identifies ARB as the State agency responsible for the design and implementation of emissions limits, regulations, and other measures to meet the target.

The statute lays out the schedule for each step of the regulatory development and implementation, as follows:

- By June 30, 2007, ARB had to publish a list of early-action GHG emission reduction measures.
- Before January 1, 2008, ARB had to identify the current level of GHG emissions by requiring statewide reporting and verification of GHG emissions from emitters and identify the 1990 levels of California GHG emissions.
- By January 1, 2010, ARB had to adopt regulations to implement the early-action measures.

In December 2007, ARB approved the 2020 GHG emission limit (1990 level) of 427 MMT CO_2e. The 2020 target requires the reduction of 169 MMT CO_2e, or approximately 30 percent below California's projected "business-as-usual" 2020 emissions of 596 MMT CO_2e.

Also in December 2007, ARB adopted mandatory reporting and verification regulations pursuant to AB 32. The regulations became effective January 1, 2009, with the first reports covering 2008 emissions. The mandatory reporting regulations require reporting for major facilities, those that generate more than 25,000 MT CO_2e per year. To date ARB has met all of the statutorily mandated deadlines for promulgation and adoption of regulations.

Climate Change Scoping Plan In December 2008, ARB adopted its Climate Change Scoping Plan, which contains the main strategies California will implement to achieve reduction of approximately 118 MMT CO_2e, or approximately 22 percent from the state's projected 2020 emission level of 545 MMT CO_2e under a business-as-usual scenario (this is a reduction of 47 MMT CO_2e, or almost 10 percent, from 2008 emissions). ARB's original 2020 projection was 596 MMT CO_2e, but this revised 2020 projection takes into account the economic downturn that occurred in 2008 (ARB 2011). In August 2011, the Scoping Plan was re-approved by ARB, and includes the Final Supplement to the Scoping Plan Functional Equivalent Document, which further-examined various alternatives to Scoping Plan measures. The Scoping Plan also includes ARB-recommended GHG reductions for each emissions sector of the state's GHG inventory. ARB estimates the largest reductions in GHG emissions to be achieved by implementing the following measures and standards (ARB 2011):

- improved emissions standards for light-duty vehicles (estimated reductions of 26.1 MMT CO_2e)
- the Low-Carbon Fuel Standard (15.0 MMT CO_2e)
- energy efficiency measures in buildings and appliances (11.9 MMT CO_2e)
- a renewable portfolio and electricity standards for electricity production (23.4 MMT CO_2e)

ARB has not yet determined what amount of GHG reductions it recommends from local government operations; however, the Scoping Plan does state that land use planning and urban growth decisions will play an important role in the state's GHG reductions because local governments have primary authority to plan, zone, approve, and permit how land is developed to accommodate population growth and the changing needs of their jurisdictions. (Meanwhile, ARB is also developing an additional protocol for community emissions.) ARB further acknowledges that decisions on how land is used will have large impacts on the GHG emissions that will result from the transportation, housing, industry, forestry, water, agriculture, electricity, and natural gas emission sectors. The Scoping Plan states that the ultimate GHG reduction assignment to local government operations is to be determined (ARB 2008). With regard to land use planning, the Scoping Plan expects approximately 3.0 MMT CO_2e will be achieved associated with implementation of SB 375, which is discussed further below (ARB 2011).

Executive Order S-13-08 Executive Order S-13-08, issued November 14, 2008, directs the Resources Agency, DWR, OPR, the California Energy Commission, the State Water Resources Control Board, the California Department of Parks and Recreation, and California's coastal management agencies to participate in planning and research activities to advance California's ability to adapt to the effects of climate change. The order specifically directs agencies to work with the National Academy of Sciences to initiate the first California sea-level-rise assessment and to review and update the assessment every 2 years after completion; immediately assess the vulnerability of California's transportation system to sea level rise; and to develop a climate change adaptation strategy for California.

California Climate Change Adaptation Strategy Developed through cooperation and partnership among multiple State agencies, the 2009 *California Climate Adaptation Strategy* summarizes the best known science on climate change effects. The strategy describes effects of climate change on seven specific sectors—public health, biodiversity and habitat, ocean and coastal resources, water management, agriculture, forestry, and transportation and energy infrastructure—and recommends ways to manage against those threats.

Governor's Office of Planning and Research Technical Advisory In June 2008, OPR published a technical advisory on CEQA and climate change to provide interim advice to lead agencies regarding the analysis of GHGs in environmental documents (OPR 2008). The advisory encourages lead agencies to identify and quantify the GHGs that could result from a proposed project, analyze impacts of those emissions to determine whether they would be significant, and identify feasible mitigation measures or alternatives that would reduce adverse impacts to a less than significant level. The advisory recognized that OPR would develop, and the Resources Agency would adopt, amendments to the State CEQA Guidelines pursuant to SB 97 (see "California Environmental Quality Act and SB 97," above).

The advisory provides OPR's perspective on the emerging role of CEQA in addressing climate change and GHG emissions. It recognizes that approaches and methodologies for calculating GHG emissions and determining their significance are rapidly evolving. OPR concludes in the technical advisory that climate change is ultimately a cumulative impact, and that no individual project could have a significant impact on global climate. Thus, projects must be analyzed with respect to the incremental impact of the project when added to other past, present, and reasonably foreseeable probable future projects. OPR recommends that lead agencies undertake an analysis, consistent with available guidance and current CEQA practice, to determine cumulative significance (OPR 2008).

The technical advisory points out that neither CEQA nor the State CEQA Guidelines prescribe thresholds of significance or particular methodologies for performing an impact analysis. “This is left to lead agency judgment and discretion, based upon factual data and guidance from regulatory agencies and other sources where available and applicable” (OPR 2008). OPR states that “the global nature of climate change warrants investigation of a statewide threshold of significance for GHG emissions” (OPR 2008). Until such a standard is established, OPR advises that each lead agency should develop its own approach to performing an analysis for projects that generate GHG emissions (OPR 2008).

OPR sets out the following process for evaluating GHG emissions. First, agencies should determine whether GHG emissions may be generated by a proposed project, and if so, quantify or estimate the emissions by type or source. Calculation, modeling, or estimation of GHG emissions should include the emissions associated with vehicular traffic, energy consumption, water usage, and construction activities (OPR 2008).

Agencies should then assess whether the emissions are “cumulatively considerable” even though a project’s GHG emissions may be individually limited. OPR states: “Although climate change is ultimately a cumulative impact, not every individual project that emits GHGs must necessarily be found to contribute to a significant cumulative impact on the environment” (OPR 2008). Individual lead agencies may undertake a project-by-project analysis, consistent with available guidance and current CEQA practice (OPR 2008).

Finally, if the lead agency determines that emissions are a cumulatively considerable contribution to a significant cumulative impact, the lead agency must investigate and implement ways to mitigate the emissions (OPR 2008). OPR (2008) states:

> *Mitigation measures will vary with the type of project being contemplated, but may include alternative project designs or locations that conserve energy and water, measures that reduce vehicle miles traveled by fossil-fueled vehicles, measures that contribute to established regional or programmatic mitigation strategies, and measures that sequester carbon to offset the emissions from the project.*

OPR concludes that “A lead agency is not responsible for wholly eliminating all GHG emissions from a project; the CEQA standard is to mitigate to a level that is “less than significant” (OPR 2008). Attachment 3 to the technical advisory includes a list of GHG reduction measures that can be applied on a project-by-project basis.

California Air Pollution Officers Association In January 2008, the California Air Pollution Control Officers Association issued a "white paper" on evaluating and addressing GHGs under CEQA (CAPCOA 2008). This resource guide was prepared to support local governments as they develop their climate change programs and policies. Though not a guidance document, the paper provides information about key elements of CEQA GHG analyses, including a survey of different approaches to setting quantitative significance thresholds. The following are some of the thresholds discussed:

- Zero (all emissions are significant)
- 900 MT CO_2e per year (90 percent market capture for residential and nonresidential discretionary development)
- 10,000 MT CO_2e per year (potential ARB mandatory reporting level for cap-and-trade program)
- 25,000 MT CO_2e per year (ARB's mandatory reporting level for the statewide emissions inventory)
- Unit-based thresholds, based on identifying thresholds for each type of new development and quantifying significance by a 90 percent capture rate

5.2.3 Regional and Local

Shasta Lake and Vicinity and Upper Sacramento River (Shasta Dam to Red Bluff)

Shasta County Air Quality Management District SCAQMD is the primary local agency regulating air quality for all of Shasta County. SCAQMD attains and maintains air quality conditions in Shasta County through a comprehensive program of planning, regulation, enforcement, technical innovation, and promotion of the understanding of air quality issues. The clean-air strategy of SCAQMD is to prepare plans and programs for the attainment of ambient air quality standards, adopt and enforce rules and regulations, and issue permits for stationary sources. SCAQMD also inspects stationary sources, responds to citizen complaints, monitors ambient air quality and meteorological conditions, and implements other programs and regulations required by the CAA, CAAA, and CCAA.

Rules and Regulations All projects in Shasta County are subject to SCAQMD rules and regulations in effect at the time of construction. Specific rules applicable to the project may include the following:

- **Rule 2:1A: Permits Required –** Any person who is building, erecting, altering, or replacing any article, machine, equipment or other contrivance, or multicomponent system including same, portable or stationary and who is not exempt under Section 42310 of the California Health and Safety Code, the use of which may cause the issuance of air contaminants, shall first obtain written authority for such construction from the Air Pollution Control Officer.

- **Rule 2:7: Conditions for Open Burning –** All material to be burned must be arranged so that it will burn with a minimum of smoke and must be reasonably free of dirt, soil, and visible surface moisture. All vegetative wastes to be burned shall be ignited only with approved ignition devices and shall be free of tires, illegal residential waste, tar paper, construction debris, and combustible and flammable waste. No burning shall cause emissions to be transported into smoke sensitive areas. No burning shall be conducted when such burns, in conjunction with present or predicted meteorology, could cause or contribute to a violation of an ambient air quality standard.

- **Rule 3:15: Cutback and Emulsified Asphalt –** A person shall not manufacture, sell, offer for sale, use, or apply for paving, construction, or maintenance of parking lots, driveways, streets, or highways any rapid- or medium-cure cutback asphalt, slow-cure cutback asphalt material that contains more than 0.5 percent by volume VOCs that boil at 500 degrees Fahrenheit (260 degrees Celsius) or less, or any emulsified asphalt material that contains more than 3.0 percent by volume of VOCs that evaporate at 500 degrees Fahrenheit (260 degrees Celsius) or less.

- **Rule 3:16: Fugitive, Indirect, or Nontraditional Sources –** The Air Pollution Control Officer may place reasonable conditions upon any source, as delineated below, that will mitigate the emissions from such sources to below a level of significance or to a point that such emissions no longer constitute a violation of Health and Safety Code Sections 41700 and/or 41701: fugitive sources, indirect sources, and nontraditional sources.

- **Rule 3:22: Asbestos –** No person shall use or apply serpentine material for surfacing in California unless the material has been tested using ARB Test Method 435 and determined to have an asbestos content of 5 percent or less. A written receipt or other record documenting the asbestos content shall be retained by any person who uses or applies serpentine material for at least 7 years from the date of use or application, and shall be provided to the Air Pollution Control Officer, or his or her designate, for review upon request.

- **Rule 3:31: Architectural Coatings** – The developer or contractor is required to use coatings that comply with the VOC content limits specified in the rule.

Criteria Pollutants SCAQMD has adopted pollutant emission thresholds and mitigation requirements that are used in the analysis of project impacts. The thresholds and mitigation requirements are discussed below in Section 5.3.2, "Criteria for Determining Significance of Effects."

Attainment Plan Air quality planning in the NSVAB has been undertaken on a joint basis by the air districts in seven counties. The current plan, the *Northern Sacramento Valley Planning Area 2012 Triennial Air Quality Attainment Plan* (AQAP), is an update of plans prepared in 1994, 1997, 2000, 2003, 2006, and 2009. The purpose of the plan is to achieve and maintain healthful air quality throughout the air basin. The 2012 AQAP addresses the progress made in implementing the 2009 plan and proposes modifications to the strategies necessary to attain the California ambient air quality standards for the 1-hour ozone standard at the earliest practicable date.

The AQAP is based on each county's projected emission inventory, which includes stationary, area-wide, and mobile sources. Emission inventories are based on general plans and anticipated development.

Toxic Air Contaminants At the local level, air pollution control or management districts may adopt and enforce ARB control measures. Under SCAQMD Rule V, "Additional Procedures For Issuing Permits To Operate For Sources Subject To Title V Of The Federal Clean Air Act Amendments Of 1990," Rule 2:1, "New Source Review," and Rule 2:1A, "Permits Required," all sources that possess the potential to emit TACs are required to obtain permits from the district. Permits may be granted to these operations if they are constructed and operated in accordance with applicable regulations, including new-source-review standards and air-toxics control measures. SCAQMD limits emissions and public exposure to TACs through a number of programs. SCAQMD prioritizes TAC-emitting stationary sources based on the quantity and toxicity of the TAC emissions and the proximity of the facilities to sensitive receptors.

Shasta County General Plan The Air Quality Element of the *Shasta County General Plan* (Shasta County 2004) contains objectives and policies aimed at protecting and improving Shasta County's air quality, meeting the requirements of the CAA and CCAA, and integrating planning efforts (e.g., transit, land use) to reduce air pollution contaminants, among others.

Tehama County Air Pollution Control District The southern portion of the primary study area is in Tehama County. The Tehama County Air Pollution Control District is the primary local agency with respect to air quality for Tehama County. The Tehama County Air Pollution Control District has rules and regulations similar to those described for SCAQMD. The Tehama County

Air Pollution Control District is in the NSVAB and is therefore a participant in NSVAB's 2003 AQAP.

Lower Sacramento River and Delta and CVP/SWP Service Areas

All areas of California are within the jurisdiction of an air pollution control district or an air quality management district. Each district has rules and regulations similar to those described above for SCAQMD. Districts that are classified as nonattainment for one or more criteria pollutants have attainment plans or similar documents as required by ARB. Most districts have guidance documents for the analysis of air quality impacts for CEQA compliance.

Global Study Area—Greenhouse Gases

There are no regional or local policies, regulations, or laws pertaining to GHG emissions.

5.3 Environmental Consequences and Mitigation Measures

5.3.1 Methods and Assumptions

Criteria Air Pollutants

The proposed SLWRI alternatives are quite complex. They consist of implementing construction activities for the dam structure; clearing the reservoir area that would be affected by the increase in pool height; relocating and modifying bridges, roads, utilities, and recreation areas; and completing other related tasks. A detailed list including each piece of heavy duty construction equipment for every construction activity to be completed under each action alternative, including proposed work hours, was available. In addition, total quantities of material hauled and imported was available. Information on daily trips for construction workers and material hauling was also available for each action alternative. Quantification of air pollutant emissions were based on a combination of methods, including the use of emission factors from the EPA's published AP-42, exhaust emission factors from the Sacramento Metropolitan Air Quality Management District's (SMAQMD) Road Construction Emissions Model, emission rates from OFFROAD 2007 and EMFAC 2011, and the California Emissions Estimator Model (CalEEMod) version 2011.1.1. The application of each methodology is described separately below.

SMAQMD's Road Construction Emissions Model, version 7.1.2 was used to obtain exhaust emission rates for ROG, NO_x, PM_{10}, CO, and CO_2 for heavy duty construction equipment that would be used for construction activities. The model uses emission rates for heavy-duty construction equipment based on OFFROAD 2007 and EMFAC 2011 (described separately below). Emission rates for 2016 (the earliest year that construction would begin) were applied to each piece of equipment based on the anticipated operation hours of equipment by construction activity and action alternative.

The off-road emissions inventory is an estimate of the population, activity, and emissions estimate of the varied types of off-road equipment within each county in California. The major categories of engines and vehicles include agricultural, construction, lawn and garden, and off-road recreation. OFFROAD was run for Shasta County in 2016 (the earliest year that construction would begin) and was used to generate emission rates for certain, specific equipment such as chippers and chainsaws that were not included in the SMAQMD Road Construction Model described above.

EMFAC 2011 is a model developed by ARB used for estimating emissions from on-road vehicles. EMFAC 2011 was run for Shasta County in 2016 (the earliest year that construction would begin) and was used to generate exhaust emission rates for worker commute trips and truck hauling trips. Emission rates were applied to daily truck trips and worker commute trips required by each action alternative.

Emission factors obtained from AP-42 were used to calculate dust emissions ($PM_{2.5}$ and PM_{10}) from construction activity (grading, earthmoving, stockpiling of material), travel on paved road for truck haul trips and for worker commute trips. For dust generated during construction activity, two primary construction activities were identified that would represent the dust emissions from all action alternatives: aggregate handling and storage piles, and grading/earth moving. AP-42 provides emission factors that estimate dust emissions from the loading of aggregate onto storage piles, equipment traffic in storage areas, wind erosion from pile surfaces, loadout of aggregate for shipment or return to the process stream (batch or continuous drop operations), and from bulldozing/grading.

Primary inputs to estimate dust from aggregate handling and storage piles included total quantities of excavated material and inputs for bulldozing/grading included total equipment hours for equipment that perform these activities (e.g., graders, bulldozers).

CalEEMod was developed in collaboration with the air districts of California. Default data (e.g., emission factors, trip lengths, meteorology, source inventory, etc.) were provided by the various California air districts to account for local requirements and conditions. CalEEMod can be used to estimate air pollutant emissions from construction activities, mobile-source emissions, and operational emissions from mobile and area sources. CalEEMod was used to estimate mobile-source emissions of criteria air pollutants (ROG, NO_x, $PM_{2.5}$, PM_{10}, and CO) from operational trips associated with visitation to the recreational sites of the project.

Toxic Air Contaminants and Odors

TACs and odors are discussed in accordance with SCAQMD, ARB, and EPA policies and rules.

Global Warming

Emissions of CO_2e from construction activities and from recreational visitors' vehicles were calculated using emission factors for heavy duty construction equipment from the SMAQMD's Road Construction Emission Model and CalEEMod 2011.1.1. Exhaust emissions from construction equipment were summed by the various construction activities under each action alternative. Mobile source GHG emissions associated with recreational visitor trips were estimated using the operational trip rates provided for each action alternative in CalEEMod. Data on emissions avoided by generation of electricity from Shasta Dam were obtained from Chapter 5 of the Shasta Lake Water Resources Investigation Plan Formulation Report (Reclamation 2007). GHG emissions from cleared and burned vegetation were estimated using the Carbon Online Estimator (COLE Development Group 2011). Indirect emissions from cement production and CO_2 absorption by water and vegetation are discussed, but not quantified.

5.3.2 Criteria for Determining Significance of Effects

An environmental document prepared to comply with NEPA must consider the context and intensity of the environmental effects that would be caused by, or result from, the proposed action. Under NEPA, the significance of an effect is used solely to determine whether an EIS must be prepared. An environmental document prepared to comply with CEQA must identify the potentially significant environmental effects of a proposed project. A "[s]ignificant effect on the environment" means a substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by the project" (State CEQA Guidelines, Section 15382). CEQA also requires that the environmental document propose feasible measures to avoid or substantially reduce significant environmental effects (State CEQA Guidelines, Section 15126.4(a)).

The following significance criteria were developed based on guidance provided by the State CEQA Guidelines, and consider the context and intensity of the environmental effects as required under NEPA. Impacts of an alternative on air quality and climate would be significant if project implementation would do any of the following:

- Conflict with or obstruct implementation of the applicable air quality plan
- Violate any air quality standard or contribute substantially to an existing or projected air quality violation
- Result in a cumulatively considerable net increase of a criteria air pollutant for which the project region is nonattainment under any applicable Federal or State ambient air quality standard (including releasing emissions that exceed quantitative thresholds for ozone precursors)

- Expose sensitive receptors to substantial pollutant concentrations
- Create objectionable odors affecting a substantial number of people
- Generate GHG emissions, either directly or indirectly, that may have a significant impact on the environment
- Conflict with any applicable plan, policy, or regulation of an agency adopted for the purpose of reducing the emissions of GHGs

As stated in Appendix G of the State CEQA Guidelines, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the above determinations. SCAQMD has adopted air quality thresholds (Table 5-3). These thresholds are based on SCAQMD New Source Review Rule 2:1. The thresholds and policy are published in the *Shasta County General Plan*.

Table 5-3. Shasta County Air Quality Management District's Air Quality Emission Thresholds

NO_X	ROG	PM_{10}	CO
Level A Thresholds			
25 lb/day	25 lb/day	80 lb/day	500 lb/day
Level B Thresholds			
137 lb/day	137 lb/day	137 lb/day	500 lb/day

Source: Shasta County 2004

Note:
These thresholds will be applied during the Shasta County Planning Division's CEQA review process. The CO thresholds do not appear in the general plan, but are included in SCAQMD policy.

Key:
CEQA = California Environmental Quality Act
CO = carbon monoxide
lb/day = pounds per day
NO_X = oxides of nitrogen
PM_{10} = respirable particulate matter
ROG = reactive organic gases
SCAQMD = Shasta County Air Quality Management District

The policy includes standard mitigation measures (SMM) and best available mitigation measures (BAMM). Briefly, the policy for applying SMMs and BAMMs is as follows:

- Apply SMM to all projects; this effort will help contribute to reducing cumulative effects.
- Apply SMM and appropriate BAMM when a project exceeds Level A thresholds.

- Apply SMM, BAMM, and special BAMM when a project exceeds Level B thresholds.

- If application of the above procedures will reduce project emissions below Level B thresholds, the project can proceed with an environmental determination of a mitigated negative declaration, assuming that other project impacts do not require more extensive environmental review.

- If project emissions cannot be reduced to below Level B thresholds, emission offsets will be required. If, after applying the emissions offsets, the project emissions still exceed the Level B threshold, an environmental impact report will be required before the project can be considered for action by the reviewing authority.

Thus, as recommended by SCAQMD, impacts of an alternative on air quality would be significant if either of the following would occur as a result of project implementation:

- Emissions of criteria air pollutants or precursors in Shasta County during construction or long-term operations would exceed the SCAQMD Level B thresholds of 137 pounds per day (lb/day) of ROG, NO_X, or PM_{10} and 500 lb/day of CO after the application of mitigation measures.

- Emissions of criteria air pollutants or precursors in Tehama County during construction or long-term operations would exceed 137 lb/day of ROG, NO_X, or PM_{10} after the application of mitigation measures.

SCAQMD has not adopted a numeric significance criterion for GHGs generated by nonindustrial projects. (However, two California air districts, the Bay Area Air Quality Management District and the South Coast Air Quality Management District, have adopted thresholds for GHG emissions generated by development projects.) No numeric thresholds adopted by any air district or by ARB would be applicable to the action alternatives. However, by adopting AB 32, the State has established GHG reduction targets. Further, the State has determined that GHG emissions, as they relate to global climate change, are a source of adverse environmental impacts in California and should be addressed under CEQA. AB 32 did not amend CEQA, although the legislation identifies the myriad environmental problems in California caused by global warming (Health and Safety Code, Section 38501(a)). SB 97, in contrast, did amend CEQA by requiring OPR to revise the State CEQA Guidelines to address the mitigation of GHG emissions or their consequences (California Public Resources Code, Sections 21083.05 and 21097).

Based on the size, scope, and purpose of this project, the following significance criteria will be used to determine the significance of GHG emissions from this project:

- Whether the project has the potential to conflict with or is consistent with the following plans to reduce or mitigate GHG emissions:
  - The six key elements of the *Climate Change Scoping Plan* (described previously)
  - ARB's 39 recommended actions in the *Climate Change Scoping Plan*
  - Regulations or requirements adopted to implement a statewide, regional, or local plan for the reduction or mitigation of GHG emissions
- Whether the project is part of a plan that includes overall reductions in GHG emissions
- Whether the relative amounts of GHG emissions over the life of the project are small in comparison to the amount of GHG emissions for major facilities that are required to report such emissions (25,000 MT CO_2e per year)
- Whether the project has the potential to contribute to a lower carbon future, through factors such as the following:
  - The design of the proposed project is inherently energy efficient
  - All applicable best management practices that would reduce GHG emissions are incorporated into the project design
  - The project implements or funds its fair share of a mitigation strategy designed to alleviate climate change
  - There are process improvements or efficiencies gained by implementing the project

5.3.3 Topics Eliminated from Further Consideration

No topics related to air quality and climate change that are included in the significance criteria listed above were eliminated from further consideration. All relevant topics are analyzed below.

5.3.4 Direct and Indirect Effects

No-Action Alternative

Shasta Lake and Vicinity and Upper Sacramento River (Shasta Dam to Red Bluff)

Impact AQ-1 (No-Action): Short-Term Emissions of Criteria Air Pollutants and Precursors at Shasta Lake and Vicinity During Project Construction No short-term, construction-related increases in emissions of criteria air pollutants or precursors at Shasta Lake or in the vicinity would result from implementation of the No-Action Alternative. No impact would occur.

Under the No-Action Alternative, no new facilities would be constructed at Shasta Lake or in the vicinity. No changes to Reclamation's existing facilities would occur that would directly or indirectly result in any increases in emissions of criteria air pollutants or precursors in this portion of the primary study area. Therefore, no impact would occur. Mitigation is not required for the No-Action Alternative.

Impact AQ-2 (No-Action): Long-Term Emissions of Criteria Air Pollutants and Precursors During Project Operation No long-term operational increases in emissions of criteria air pollutants or precursors in the primary study area would result from implementation of the No-Action Alternative. However, PM_{10} emissions are expected to continue increasing through 2020 because of increased growth in the area. This impact would be less than significant.

Under the No-Action Alternative, no changes to Reclamation's existing operations in the primary study area would occur that would directly or indirectly result in any increases in emissions of criteria air pollutants or precursors in the primary study area. According to ARB, emission levels for ROG, NO_X, and CO are trending downward from 1990 to 2020 in the project area even with increased population growth (ARB 2009). More stringent mobile-source emission standards, cleaner burning fuels, and new rules have largely contributed to this decline. However, PM_{10} emissions are expected to continue increasing through 2020 because of increased growth in the area and associated emissions (e.g., from travel on paved and unpaved roads). Thus, such emissions will likely be worse in the future. Therefore, this impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Impact AQ-3 (No-Action): Exposure of Sensitive Receptors to Substantial Pollutant Concentrations The No-Action Alternative would not change existing exposure of sensitive receptors to pollutants. No impact would occur.

Sensitive receptors in the primary study area are not currently exposed to substantial pollutant concentrations. There is no indication of circumstances under the No-Action Alternative that would change exposure levels. Therefore, no impact would occur. Mitigation is not required for the No-Action Alternative.

Impact AQ-4 (No-Action): Exposure of Sensitive Receptors to Odor Emissions The No-Action Alternative would not change existing exposure of sensitive receptors to odors. No impact would occur.

Sensitive receptors in the primary study area are not currently exposed to substantial concentrations of odors. There is no indication of circumstances under the No-Action Alternative that would change the exposure. Therefore, no impact would occur. Mitigation is not required for the No-Action Alternative.

Impact AQ-5 (No-Action): Short-Term Emissions of Criteria Air Pollutants and Precursors Below Shasta Dam During Project Construction No short-term, construction-related increases in emissions of criteria air pollutants or precursors below Shasta Dam would result from implementation of the No-Action Alternative. No impact would occur.

The Gravel Augmentation Program (proposed under CP4, CP4A, and CP5, as described below) would not be implemented under the No-Action Alternative. No new facilities would be constructed below Shasta Dam. Furthermore, no changes to Reclamation’s existing facilities or operations would occur that would directly or indirectly result in any increases in emissions of criteria air pollutants in this portion of the primary study area. No impact would occur. Mitigation is not required for the No-Action Alternative.

Lower Sacramento River and Delta and CVP/SWP Service Areas No effects on climate and air quality are expected to occur in the lower Sacramento River and Delta and CVP/SWP service areas under the No-Action Alternative; therefore, potential effects in those geographic regions are not discussed further in this EIS.

Global Study Area

Impact AQ-6 (No-Action): Generation of Greenhouse Gases State goals to reduce project-related GHG emissions would not be implemented under this alternative; however, the No-Action Alternative would not obstruct or conflict with those goals. This impact would be less than significant.

Under the No-Action Alternative, no new facilities would be constructed. No changes to Reclamation’s existing facilities or operations would occur that would directly or indirectly result in any increases or decreases in GHG emissions. Therefore, no efforts would be made to reduce existing GHG emissions in the project vicinity under this alternative. Although the State’s goals to reduce GHG emissions would not be implemented, the No-Action Alternative would not obstruct or conflict with those goals. Therefore, this impact would be less than significant. Mitigation is not required for the No-Action Alternative.

CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

Shasta Lake and Vicinity

Impact AQ-1 (CP1): Short-Term Emissions of Criteria Air Pollutants and Precursors at Shasta Lake and Vicinity During Project Construction Project construction could result in short-term emissions (e.g., ROG, NO_x, and PM) that exceed applicable SCAQMD thresholds. This conclusion is based on detailed calculations of estimated emissions for project elements and the simultaneous occurrence thereof. Shasta County is a nonattainment area for the State ozone and PM_{10} standards. Thus, short-term emissions generated during construction could contribute substantially to an existing or projected air quality violation. This impact would be significant.

Construction emissions are described as "short-term" or temporary in duration because they would cease when the dam raise and associated construction projects are completed. The emissions of ozone precursors ROG and NO_X are associated primarily with gas and diesel engine equipment exhaust from off-road equipment and on-road vehicles. Off-road equipment anticipated in the project includes construction equipment such as bulldozers, graders, water trucks, and loaders. On-road vehicles include trucks that would bring materials to the project site and haul excavated spoils and materials cleared from lands away from the project site. An additional on-road source would be the vehicles used by workers commuting to and from the project site. Engine equipment exhaust also emits CO, PM_{10}, and $PM_{2.5}$. Refer to Attachment 1 to the *Air Quality and Climate Technical Report* for all air quality modeling inputs and outputs.

The primary sources of PM_{10} and $PM_{2.5}$ emissions are fugitive dust from site preparation, vehicle travel on unpaved and paved roads, and storage piles. Emissions vary as a function of such parameters as soil silt content, soil moisture, wind speed, acreage of disturbance area, and vehicle miles traveled by construction vehicles on- and off-site. Burning of cleared vegetation would also be a source of particulate emissions. PM_{10} and $PM_{2.5}$ would also be emitted during the materials handling processes associated with operation of a concrete batch plant.

Major construction elements under CP1 would be the dam raise of 6.5 feet and the clearing of land that would be inundated by the larger full pool. Land-clearing equipment used would be based on the terrain, and would range from full-size bulldozers to smaller backhoes and hand tools. In steep terrain helicopters would be used for material removal. In addition, wing dams and reservoir dikes would be constructed; railroad and roadway bridges would be replaced; roads, structures, and utilities would be relocated; and excavation and loading would occur at borrow areas to provide materials for dam construction.

Emissions were calculated as described above in Section 5.3.1, "Methods and Assumptions." The results are shown in Table 5-4 for individual project elements. (All air quality modeling inputs and outputs for the Comprehensive Plans (CP) are presented in Attachment 1 to the *Air Quality and Climate Technical Report*.) As seen in Table 5-4, ROG, NO_X, and PM emissions for several of the individual project elements could exceed applicable Shasta County thresholds, which would result in a significant impact. As shown in Figures 5-2 to 5-8, maximum daily emissions (lb/day) for CP1 could reach 260 for ROG, 1,682 for NO_x, 107 for PM_{10} exhaust, 2,944 for PM_{10} dust, 93 for $PM_{2.5}$ exhaust, 309 for $PM_{2.5}$ dust, and 1,125 for CO based on the worst-case simultaneous construction of project elements as shown in detail in Attachment 1 to the *Air Quality and Climate Change Technical Report*.

Particulate emissions from operation of a concrete batch plant are not included in the above calculations. Batch plants must obtain operating permits from Shasta County Air Pollution Control District. The granting of a permit would assure that the impact of PM_{10} and $PM_{2.5}$ emissions from batch plant sources would not exceed applicable thresholds.

Based on the data in Table 5-4 and the preceding discussion, short-term emissions generated during construction could contribute substantially to an existing or projected air quality violation. As a result, this impact would be significant.

The Shasta County standards require SMMs for all projects and additional mitigation measures when project emissions are anticipated to exceed applicable thresholds. Mitigation for this impact that incorporates these mitigation measures is proposed in Section 5.3.5.

Table 5-4. Summary of Daily Short-Term Construction-Generated Emissions by Project Element (Pounds per Day) – CP1[1]

Project Element for 6.5-Foot Raise (Activities)	ROG	NO_x	PM_{10} Exh.	PM_{10} Dust	$PM_{2.5}$ Exh.	$PM_{2.5}$ Dust	CO
UPRR Doney Creek Bridge	20	140	8	34	7	5	82
Left Wing Dam	18	138	7	165	6	18	106
Main Concrete Dam	20	138	8	26	2	4	90
Outlet Works	13	138	5	26	5	4	53
Pit River Bridge Pier 3 and 4 Protection	15	138	6	26	5	4	66
Powerplant and Penstocks	12	138	4	26	4	4	48
Railroad Realignment	12	138	4	159	4	17	53
Right Wing Dam	11	138	3	54	3	7	45
Sacramento River UPRR 2nd Crossing	28	141	12	35	11	5	121
Spillway	27	139	11	26	10	4	113

Table 5-4. Summary of Daily Short-Term Construction-Generated Emissions by Project Element (Pounds per Day) – CP1[1] (contd.)

Project Element for 6.5-Foot Raise (Activities)	ROG	NO_x	PM_{10} Exh.	PM_{10} Dust	$PM_{2.5}$ Exh.	$PM_{2.5}$ Dust	CO
TCD Modifications	20	138	8	26	8	4	82
Visitor Center Replacement	10	138	3	43	3	6	41
Vehicular Bridges	24	155	10	34	9	5	110
Reservoir Clearing	35	260	12	27	11	4	112
Dikes	28	138	12	902	11	91	100
Buildings/Facilities – Recreation	40	141	20	1,483	18	150	166
Roads[2]	28	138	12	588	11	60	102
Utilities	18	138	7	26	6	4	70

Note:
[1] Totals may not add due to rounding
[2] Quantities modeled are greater than EIS road quantities

Key:
CO = carbon monoxide
CP = Comprehensive Plan
Exh.= exhaust
NO_X = oxides of nitrogen
$PM_{2.5}$ = fine particulate matter
PM_{10} = respirable particulate matter
ROG = reactive organic gases
TCD = temperature control device
UPRR = Union Pacific Railroad

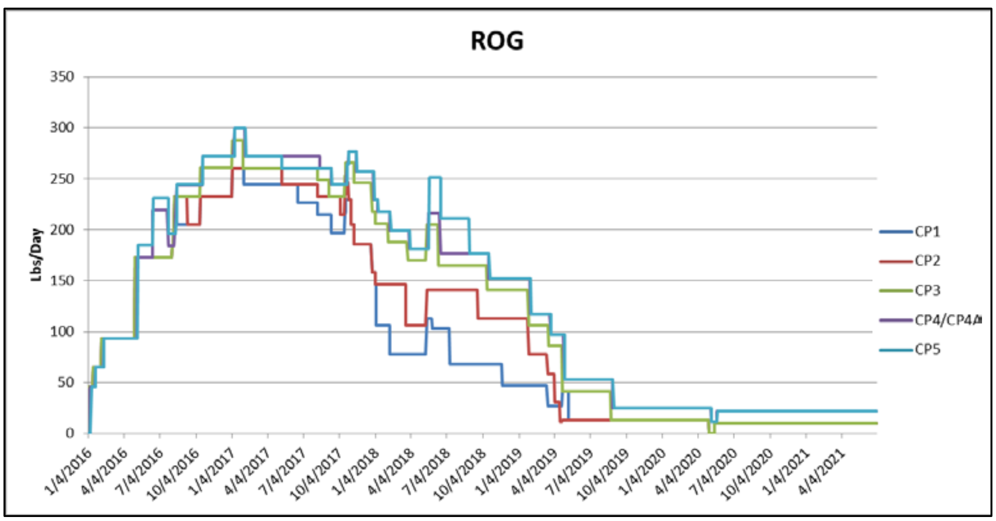


Figure 5-2. Maximum Daily Short-Term Construction-Generated Emissions of Reactive Organic Gases by Action Alternative (Pounds per Day)

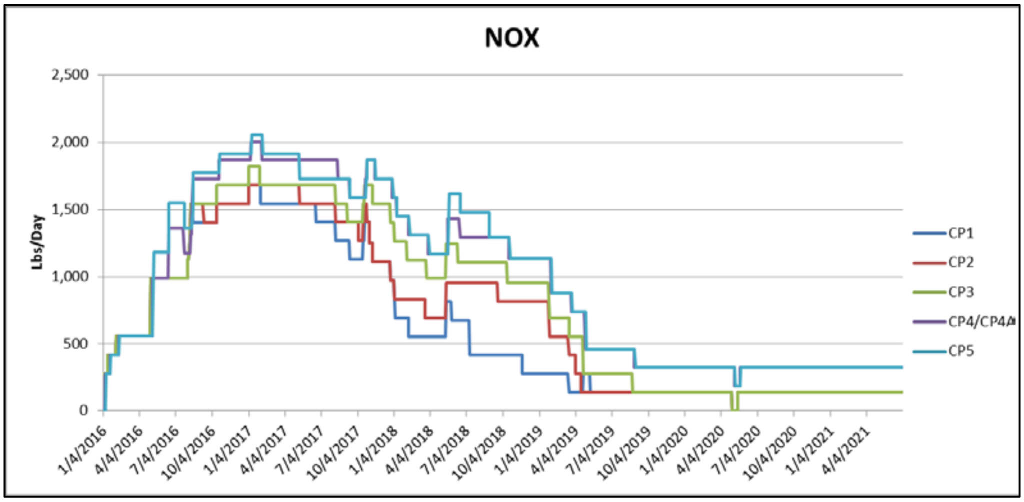


Figure 5-3. Maximum Daily Short-Term Construction-Generated Emissions of Oxides of Nitrogen by Action Alternative (Pounds per Day)

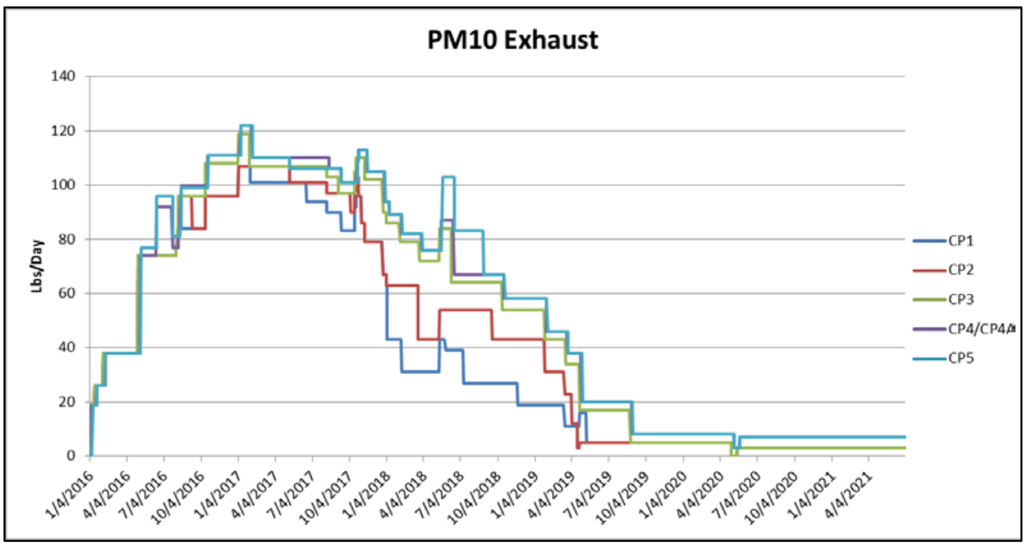


Figure 5-4. Maximum Daily Short-Term Construction-Generated Emissions of Respirable Particulate Matter Exhaust by Action Alternative (Pounds per Day)

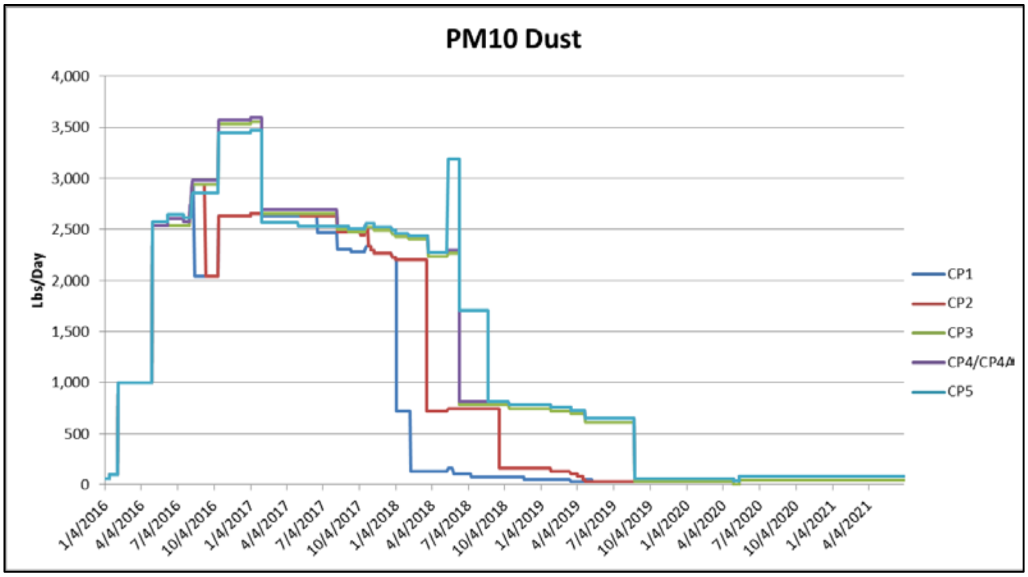


Figure 5-5. Maximum Daily Short-Term Construction-Generated Emissions of Respirable Particulate Matter Dust by Action Alternative (Pounds per Day)

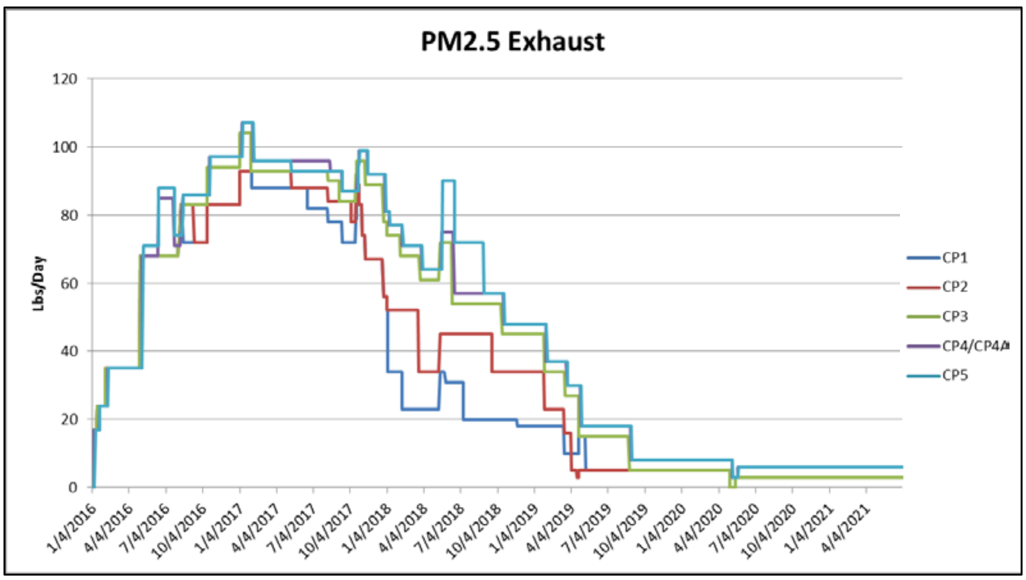


Figure 5-6. Maximum Daily Short-Term Construction-Generated Emissions of Fine Particulate Matter Exhaust by Action Alternative (Pounds per Day)

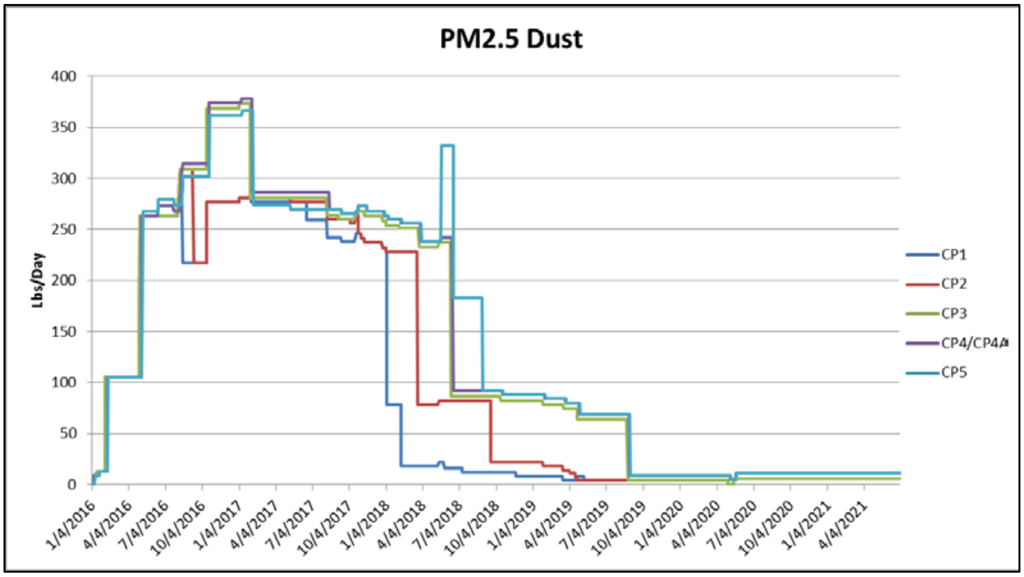


Figure 5-7. Maximum Daily Short-Term Construction-Generated Emissions of Fine Particulate Matter Dust by Action Alternative (Pounds per Day)

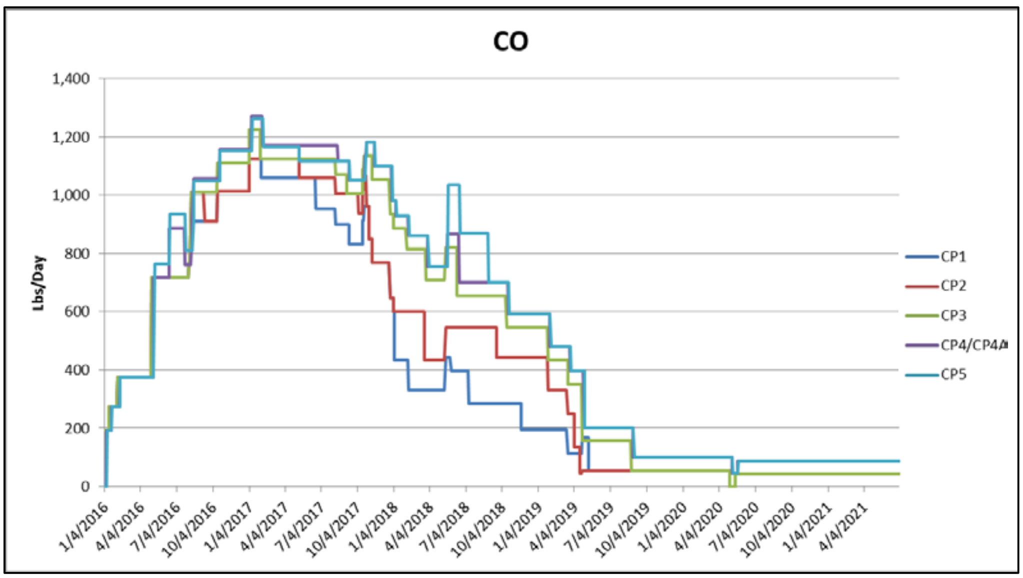


Figure 5-8. Maximum Daily Short-Term Construction-Generated Emissions of Carbon Monoxide by Action Alternative (Pounds per Day)

Impact AQ-2 (CP1): Long-Term Emissions of Criteria Air Pollutants and Precursors During Project Operation Long-term project operation is not anticipated to result in ROG, NO_X, PM_{10}, or CO emissions that exceed applicable SCAMQD thresholds. Thus, long-term operational emissions would not be anticipated to violate an air quality standard or contribute substantially to an existing or projected air quality violation. This impact would be less than significant.

Long-term operational emissions would come from stationary, area, and mobile sources. Stationary sources could include emergency generators powered by diesel engines or pumps, boilers, and major kitchen equipment. No new stationary sources of note are anticipated as part of the project. Pollutant-emitting replacement equipment would be anticipated to be similar to equipment presently in operation.

Area sources include gas-fired building heating and hot water equipment, landscape maintenance equipment, and architectural coatings (paints, lacquers) used in maintenance. Area-source increases would be anticipated to be negligible.

After completion of the dam raise, the principal sources of long-term emissions would be mobile sources; an increase in vehicle trips would result from increased recreational activity at Shasta Lake and the associated recreation areas. It is assumed that maintenance activity for the dam and recreation areas would not change markedly. No new stationary sources of emissions would be anticipated as part of the project.

Enlarging Shasta Dam would include facilities to ensure that at least the existing recreation capacity is maintained. CP1would affect recreation participation by increasing the reservoir's surface area and decreasing reservoir draw-down during the peak recreation season. Table 5-5 compares user days (visitor days) for each of the CPs to existing and future conditions. The Modeling Appendix provides additional information on recreational visitation estimates.

Table 5-5. Average Annual Predicted Increase in User Days [1]

Item	CP1	CP2	CP3	CP4	CP4A	CP5
Existing Conditions						
Increase in user days per year (thousands)	78	164	216	363	308	199
Future Conditions						
Increase in user days per year (thousands)	89	134	205	370	259	175

Note:
[1] All alternatives are to include features to, at minimum, maintain existing Shasta Lake recreation capacity.

Key:
CP = Comprehensive Plan

The increase in recreational opportunities and visitor days would generate vehicle trips for the travel of visitors to and from the Shasta Lake area. Increased trip generation and vehicle emissions were calculated using CalEEMod and the following assumptions:

- The average visitor stay is 2.5 days.

- The average number of visitors per vehicle is 2.5.
- The recreation season for most visitors is 180 days.
- The average one-way trip distance for visitors is 25 miles.
- The first year of operations is expected to be 2015 or later.

With these assumptions and 78,000 increased visitor days under existing conditions from Table 5-5, there would be an increase of an average of 138 one-way trips per day for CP1 under existing conditions. With these assumptions and 89,000 increased visitor days under future conditions from Table 5-5, there would be an increase of an average of 158 one-way trips per day for CP1 under future conditions.

The results of the emissions calculations are shown in Table 5-6. Anticipated emissions would be less than the SCAQMD significance thresholds.

Table 5-6. Operations Emissions for Shasta Dam Raise, 2015 – CP1

Activity	Emissions—pounds per day						
	ROG	NO_x	PM_{10} Exh.	PM_{10} Dust	$PM_{2.5}$ Exh.	$PM_{2.5}$ Dust	CO
Existing Conditions							
Vehicle trips for increase in recreational visitors	1.1	3.6	0.1	1.9	0.1	-	7.8
Future Conditions							
Vehicle trips for increase in recreational visitors	1.2	4.1	0.1	2.2	0.1	-	8.9

Note:
Totals may not add due to rounding.

Key:
CO = carbon monoxide
CP = Comprehensive Plan
Exh. = exhaust
NO_X = oxides of nitrogen
$PM_{2.5}$ = fine particulate matter
PM_{10} = respirable particulate matter
ROG = reactive organic gases

Based on the above analysis, operation under CP1 would not result in ROG, NO_X, PM_{10}, or CO emissions that exceed applicable SCAQMD Level A thresholds. Consequently, long-term emissions during project operation under CP1 would not be anticipated to violate an air quality standard or contribute substantially to an existing or projected air quality violation. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact AQ-3 (CP1): Exposure of Sensitive Receptors to Substantial Pollutant Concentrations Neither short-term construction nor long-term operational sources would expose sensitive receptors to substantial concentrations of CO, PM_{10}, $PM_{2.5}$, or TACs. This impact would be less than significant.

Pollutants of concern for exposure of sensitive receptors include CO, PM_{10} and $PM_{2.5}$, and TACs. Local exposure of CO may occur near severe congestion on major roadways. The project is not anticipated to generate areas of severe roadway congestion, nor would the project locate receptors near major roadways; no local CO impact would occur.

Sensitive receptors could be exposed to substantial amounts of PM_{10} and $PM_{2.5}$ if receptors were located near large areas of grading or earthmoving and dust generation was not controlled. Similarly, substantial exposure to particulates and other smoke-borne pollutants could result if receptors were near areas where cleared brush would be burned. There are no sensitive receptors near the dam raise areas; however, there may be sensitive receptors near the some of the lands that would be cleared before inundation by the expanded reservoir. Dust control measures would be required for all land clearing activities; these measures would prevent most PM_{10} and $PM_{2.5}$ from reaching sensitive receptors. Similarly, smoke control measures would be required by SCAQMD Rule 2:7. The impact of exposure of sensitive receptors to PM_{10} and $PM_{2.5}$ would be less than significant.

The principal TAC of concern for project construction is diesel PM. Diesel PM would be generated in the exhaust of diesel engine construction equipment. The largest concentration of diesel engines would be located at the dam raise site. There are no sensitive receptors within one-half mile of the dam site, and sensitive receptors would not be exposed to diesel PM from that source. Diesel equipment would be used for land clearing operations, and there may be sensitive receptors near the land clearing. The dose to which receptors are exposed is the primary factor used to determine health risk (i.e., potential exposure to TAC emission levels that exceed applicable standards). Dose is a function of the concentration of a substance or substances in the environment and the duration of exposure to the substance. Dose is positively correlated with time, meaning that a longer exposure period would result in a higher exposure level for the maximally exposed individual. Thus, the risks estimated for a maximally exposed individual are higher if a fixed exposure occurs over a longer period of time. According to the Office of Environmental Health Hazard Assessment, health risk assessments, which determine the exposure of sensitive receptors to TAC emissions, should be based on a 70-year exposure period; however, such assessments should be limited to the period/duration of activities associated with the project. Thus, because the use of off-road construction equipment would be limited to a few days near any sensitive receptor, short-term construction activities would not result in exposure of sensitive receptors to substantial TAC emissions.

Project implementation is not expected to result in the operation of any new significant sources of TAC emissions after construction is complete. Thus, short-term construction and long-term operational sources would not expose sensitive receptors to substantial TAC concentrations. As a result, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact AQ-4 (CP1): Exposure of Sensitive Receptors to Odor Emissions Short-term construction and long-term operational sources would not expose sensitive receptors to substantial odor emissions. This impact would be less than significant.

The occurrence and severity of odor impacts depend on numerous factors: the nature, frequency, and intensity of the source; wind speed and direction; and the presence of sensitive receptors. Although offensive odors rarely cause any physical harm, they still can be very unpleasant, leading to considerable distress and often generating citizen complaints to local governments and regulatory agencies.

Diesel exhaust has some odor, but it dissipates rapidly from the source with an increase in distance. There are no sensitive receptors immediately adjacent to the project site and people would not be exposed to substantial odors in that area. At other work sites, construction equipment use would be intermittent and temporary, resulting in an odor impact that would be less than significant.

Project implementation would not develop any major sources of odor. The project does not include one of the common types of facilities that are known to produce odors such as a landfill or a coffee roaster. Thus, short-term construction and long-term operational sources would not expose sensitive receptors to substantial odor emissions. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact AQ-5 (CP1): Short-Term Emissions of Criteria Air Pollutants and Precursors Below Shasta Dam During Project Construction Gravel augmentation and habitat restoration in the upper Sacramento River proposed under CP4, CP4A, and CP5 would not be implemented under CP1. No other project construction or long-term operation activities that would affect emissions of criteria air pollutants and precursors are planned in the Shasta Dam-to-Red Bluff area under CP1. Therefore, no impact would occur.

Gravel augmentation and habitat restoration (proposed under CP4, CP4A, and CP5, as described below) would not be implemented under CP1. No new facilities would be constructed below Shasta Dam under this alternative, and no changes in Reclamation’s existing facilities or operations would occur that would directly or indirectly result in any increases in criteria air pollutant emissions in this portion of the primary study area. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta and CVP/SWP Service Areas No effects on climate and air quality are expected to occur in the lower Sacramento River and Delta and CVP/SWP service areas under CP1; therefore, potential effects in those geographic regions are not discussed further in this EIS.

Global Study Area

Impact AQ-6 (CP1): Generation of Greenhouse Gases Project construction and operational activities would result in emission of a less than significant quantity of GHGs. Overall, implementation of CP1 would result in beneficial effects on GHG emissions because generation of electricity at Shasta Dam would increase. This impact would be less than significant.

There are no established quantitative criteria under CEQA for determining a significant impact related to GHG emissions. The criteria suggested by various agencies principally address long-term emissions, and not the relatively short-term emissions of construction activities. One of the more commonly suggested mass emissions thresholds is 25,000 MT CO_2e per year. This value has been selected because it is the threshold established for mandatory emissions reporting for most sources in California under AB 32. Due to a longer than usual period of construction, construction-generated emissions are amortized over the lifetime of the project and added to operational emissions to determine the overall level of GHG generation. Based on the modeling conducted, construction of CP1 would result in 3,319 MT CO_2e/year amortized over the project lifetime.

GHG emissions of sequestered carbon in removed vegetation were calculated at 3,156 MT CO_2e per year for CP1. This calculation assumes that all vegetation removal, overstory removal, and relocation acreages (370 acres total) would be covered in 70-year-old stands of forest vegetation (Ponderosa pine, Douglas-fir, montane hardwood-conifer, and montane hardwood forest) and that all above-ground vegetation would be disposed of in a manner that releases the sequestered carbon into the atmosphere. All 370 acres would not be covered with 70-year forest as used in the model (ages would vary) or release all carbon to the atmosphere. Also, most utilities would be relocated in roadways, but separate relocation (and additional disturbance) was assumed in the estimated relocation acreages. This approach was applied to ensure that underestimating would not occur.

With implementation of CP1, increased activity by recreational visitors to the Shasta Lake area would result in additional vehicle trips and estimated CO_2e emissions of 296 MT/year under existing conditions and 337 MT/year under future conditions based on the same assumptions described above (Table 5-5). Increasing the size of Shasta Dam and Shasta Lake would result in the ability to increase hydropower generation at Shasta generating facilities. Generation of electricity by hydropower reduces the need for fossil-fuel generation of electricity and the GHG emissions that would occur with that generation.

For existing conditions, raising Shasta Dam by 6.5 feet and implementing the operational strategy for CP1 would result in a net increase in CVP/SWP power generation of 3 gigawatt-hours (GWh) [1] per year (Table 5-7). This net generation estimate accounts for the energy required for pumping the increased water supplies. Fossil-fuel generation of 3 GWh of energy would produce an estimated 2,700 MT of CO_2e, also shown in Table 5-7. Therefore, the increased generation of electricity at Shasta Dam in the near term would reduce the need to build facilities for fossil-fueled generation of 3 GWh per year in the global study area.

For future conditions, however, raising Shasta Dam by 6.5 feet and implementing the operational strategy for CP1 would result in a net decrease in CVP/SWP power generation of 3 GWh per year (Table 5-7). Fossil-fuel generation of 3 GWh of energy would produce an estimated 2,700 MT of CO_2e, also shown in Table 5-7. Therefore, the overall net generation decrease would increase the need to build facilities for fossil-fueled generation of 3 GWh per year in the global study area.

Table 5-7. Average Annual Hydropower CVP/SWP Generation

Item	CP1	CP2	CP3	CP4	CP4A	CP5
Existing Condition (2005)						
Net increased generation (GWh/year)	3	14	66	70	48	21
CO_2e displaced (1,000 metric tons)	2.7	12.5	59.0	62.5	42.8	18.7
Future Condition (2030)						
Net increased generation (GWh/year)	(3)	1	65	64	33	1
CO_2e displaced (1,000 metric tons)	(2.7)	0.9	58.1	57.1	29.4	0.9

Key:
CO_2e = carbon dioxide equivalent
CP = Comprehensive Plan
GWh/year = gigawatt-hours per year

The results of the above analysis show that CP1 would result in short-term emissions of GHG for the years of construction, followed by long-term benefits of GHG reduction through generation of electricity at Shasta Dam for existing conditions. The results of the above analysis show that CP1 would result in short-term emissions of GHG for the years of construction, followed by a long-term effect of GHG increase for future conditions. The GHG emissions from construction activities would be temporary in duration and mitigated to the extent feasible; therefore, such emissions would not conflict with State or

[1] Net power generation values throughout this chapter account for providing in-kind power to offset reduced generation at Pit 7 Dam and related facilities. Net power generation values were rounded to the nearest gigawatt-hour in air quality evaluations.

regional planning efforts or emit GHG in excess of mandatory reporting standards. GHG emissions from long-term operations would likely have a net benefit as a result of increased hydroelectric generation and would thus also not conflict with planning efforts or mandatory reporting thresholds. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

In addition to the effects described above, the loss of vegetation presently in the area that would be inundated would likely result in a loss of CO_2 absorption by that vegetation, as well as increased emissions of decomposing material present in the lake as a result of increased volume. There may be some offset to this effect with increased surface area of Shasta Lake for absorption. These effects are speculative and infeasible to quantify at this time.

CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

Shasta Lake and Vicinity

Impact AQ-1 (CP2): Short-Term Emissions of Criteria Air Pollutants and Precursors at Shasta Lake and Vicinity During Project Construction Project construction could result in short-term emissions (e.g., ROG, NO_x, and PM) that exceed applicable SCAQMD thresholds. This conclusion is based on detailed calculations of estimated emissions for project elements and the simultaneous occurrence thereof. Shasta County is a nonattainment area for the State ozone and PM_{10} standards. Thus, short-term emissions generated during construction could contribute substantially to an existing or projected air quality violation. This impact would be significant.

CP2 includes a dam raise of 12.5 feet. This impact would be similar to Impact AQ-1 (CP1) as the same type of construction equipment and activities would be involved. Emissions were calculated as described above in Section 5.3.1, “Methods and Assumptions.” The results are shown in Table 5-8 for individual project elements. (All air quality modeling inputs and outputs for the CPs are presented in Attachment 1 to the *Air Quality and Climate Technical Report*.) As shown in Table 5-8 (similar to CP1), ROG, NO_x, and PM emissions for several of the individual project elements could exceed applicable Shasta County thresholds, which would result in a significant impact. As shown in Figures 5-2 to 5-8, maximum daily emissions (lb/day) for CP2 (similar to CP1), could reach much higher levels based on the worst-case simultaneous construction of project elements as shown in detail in Attachment 1 to the *Air Quality and Climate Change Technical Report*. For the same reasons as described for CP1, this impact would be significant. Mitigation for this impact is proposed in Section 5.3.5.

Table 5-8. Summary of Daily Short-Term Construction-Generated Emissions by Project Element (Pounds per Day) – CP2 [1]

Project Element for 12.5-Foot Raise (Activities)	ROG	NOx	PM_{10} Exh.	PM_{10} Dust	$PM_{2.5}$ Exh.	$PM_{2.5}$ Dust	CO
UPRR Doney Creek Bridge	20	140	8	34	7	5	82
Left Wing Dam	18	138	7	165	6	18	106
Main Concrete Dam	20	138	8	26	2	4	90
Outlet Works	13	138	5	26	5	4	53
Pit River Bridge Pier 3 and 4 Protection	15	138	6	26	5	4	66
Powerplant and Penstocks	12	138	4	26	4	4	48
Railroad Realignment	12	138	4	159	4	17	53
Right Wing Dam	11	138	3	54	3	7	45
Sacramento River UPRR 2nd Crossing	28	141	12	35	11	5	121
Spillway	27	139	11	26	10	4	113
TCD Modifications	20	138	8	26	8	4	82
Visitor Center Replacement	10	138	3	43	3	6	41
Vehicular Bridges	24	155	10	34	9	5	110
Reservoir Clearing	35	260	12	27	11	4	112
Dikes	28	138	12	902	11	91	100
Buildings/Facilities – Recreation	40	141	20	1,483	18	150	166
Roads [2]	28	138	12	588	11	60	102
Utilities	18	138	7	26	6	4	70

Notes:
[1] Totals may not add due to rounding
[2] Quantities modeled are greater than Environmental Impact Statement road quantities

Key:
CO = carbon monoxide
CP = Comprehensive Plan
Exh.= exhaust
NO_X = oxides of nitrogen
$PM_{2.5}$ = fine particulate matter
PM_{10} = respirable particulate matter
ROG = reactive organic gases
TCD = temperature control device
UPRR = Union Pacific Railroad

Impact AQ-2 (CP2): Long-Term Emissions of Criteria Air Pollutants and Precursors During Project Operation Long-term project operation is not anticipated to result in ROG, NO_X, PM_{10}, or CO emissions that exceed applicable SCAQMD thresholds. Thus, long-term operational emissions would not be anticipated to violate an air quality standard or contribute substantially to an existing or projected air quality violation. This impact would be less than significant.

Long-term operational emissions would come from stationary, area, and mobile sources. This impact would be the same as Impact AQ-2 (CP1) for stationary and area sources and similar to Impact AQ-2 (CP1) for mobile sources. With CP2, there would be an annual increase of 164,000 and 134,000 visitor days under existing and future conditions, respectively, as was shown in Table 5-5, resulting in 291 and 238 average daily trips under existing and future conditions, respectively. The associated daily emissions are shown in Table 5-9.

Based on the above analysis, operation under CP2 would not result in ROG, NO_X, PM_{10}, or CO emissions that exceed applicable SCAQMD Level A thresholds. Consequently, long-term emissions during project operation under CP2 would not violate an air quality standard or contribute substantially to an existing or projected air quality violation. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 5-9. Operations Emissions for Shasta Dam Raise, 2015 – CP2

Activity	Emissions – pounds per day						
	ROG	NO_x	PM_{10} Exh.	PM_{10} Dust	$PM_{2.5}$ Exh.	$PM_{2.5}$ Dust	CO
Existing Conditions							
Vehicle trips for increase in recreational visitors	2.2	7.6	0.2	4.0	0.2	0.1	16.5
Future Conditions							
Vehicle trips for increase in recreational visitors	1.8	6.2	0.2	3.3	0.2	0.1	13.5

Note:
Totals may not add due to rounding.

Key:
CO = carbon monoxide
CP = Comprehensive Plan
Exh. = exhaust
NO_X = oxides of nitrogen
$PM_{2.5}$ = fine particulate matter
PM_{10} = respirable particulate matter
ROG = reactive organic gases

Impact AQ-3 (CP2): Exposure of Sensitive Receptors to Substantial Pollutant Concentrations Neither short-term construction nor long-term operational sources would expose sensitive receptors to substantial concentrations of CO, PM_{10}, $PM_{2.5}$, or TACs. This impact would be less than significant.

This impact would be the same as Impact AQ-3 (CP1) and would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact AQ-4 (CP2): Exposure of Sensitive Receptors to Odor Emissions Short-term construction and long-term operational sources would not expose sensitive receptors to substantial odor emissions. This impact would be less than significant.

This impact would be the same as Impact AQ-4 (CP1) and would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Upper Sacramento River (Shasta Dam to Red Bluff)
Impact AQ-5 (CP2): Short-Term Emissions of Criteria Air Pollutants and Precursors Below Shasta Dam During Project Construction Gravel augmentation and habitat restoration in the upper Sacramento River proposed under CP4, CP4A, and CP5 would not be implemented under CP2. No other project construction or long-term operation activities that would affect emissions of criteria air pollutants and precursors are planned in the Shasta Dam-to-Red Bluff area under CP2. Therefore, no impact would occur.

This impact would be the same as Impact AQ-5 (CP1). No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta and CVP/SWP Service Areas No effects on climate and air quality are expected to occur in the lower Sacramento River and Delta and CVP/SWP service areas under CP2; therefore, potential effects in those geographic regions are not discussed further in this EIS.

Global Study Area
Impact AQ-6 (CP2): Generation of Greenhouse Gases Project construction and operational activities would result in emission of a less than significant quantity of GHGs. Overall, implementation of CP2 would result in beneficial effects on GHG emissions because generation of electricity at Shasta Dam would increase. This impact would be less than significant.

This impact would be similar to Impact AQ-6 (CP1) for construction and operations. Based on the modeling conducted, construction of CP2 would result in 3,807 MT CO_2e/year amortized over the project lifetime. GHG emissions of sequestered carbon in removed vegetation were calculated at 5,031 MT CO_2e per year for CP2 (590 acres total). Increased activity by recreational visitors to the Shasta Lake area would result in additional vehicle trips and estimated CO_2 emissions of 622 and 507 MT CO_2e per year for existing conditions and future conditions, respectively.

For existing conditions, raising Shasta Dam by 12.5 feet and implementing the operational strategy for CP2 would result in a net increase in CVP/SWP power generation of 14 GWh per year (Table 5-7). Fossil-fuel generation of 14 GWh of energy would produce an estimated 12,500 MT CO_2e, also shown in Table 5-7. Thus, CP2 would reduce the need to build facilities for fossil-fueled generation of 14 GWh per year in the global study area.

For future conditions, raising Shasta Dam by 12.5 feet and implementing the operational strategy for CP2 would result in a net increase in CVP/SWP power generation of 1 GWh per year (Table 5-7). Fossil-fuel generation of 1 GWh of energy would produce an estimated 900 MT of CO_2e, also shown in Table 5-7.

Therefore, the overall net generation increase would reduce the need to build facilities for fossil-fueled generation of 1 GWh per year in the global study area.

Thus, the results of the above analysis show that CP2 would result in short-term emissions of GHG for the years of construction, followed by long-term benefits of GHG reduction through generation of electricity at Shasta Dam for existing conditions. The results of the above analysis show that CP2 would result in short-term emissions of GHG for the years of construction, followed by a long-term effect of GHG increase for future conditions. Considering construction emissions, the magnitude of the GHG "savings" for each year of operation would be approximately 3,040 MT CO_2e for existing conditions and a GHG "deficit" of 8,400 MT CO_2e for future conditions amortized over the project lifetime. The GHG emissions from construction activities would be temporary in duration and mitigated to the extent feasible; therefore, such emissions would not conflict with State or regional planning efforts or emit GHG in excess of mandatory reporting standards. GHG emissions from long-term operations would likely not conflict with planning efforts or mandatory reporting thresholds. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CP3 – 18.5-Foot Dam Raise, Anadromous Fish Survival and Agricultural Water Supply

Shasta Lake and Vicinity

Impact AQ-1 (CP3): Short-Term Emissions of Criteria Air Pollutants and Precursors at Shasta Lake and Vicinity During Project Construction Project construction could result in short-term emissions (e.g., ROG, NO_x, and PM) that exceed applicable SCAQMD thresholds. This conclusion is based on detailed calculations of estimated emissions for project elements and the simultaneous occurrence thereof. Shasta County is a nonattainment area for the State ozone and PM_{10} standards. Thus, short-term emissions generated during construction could contribute substantially to an existing or projected air quality violation. This impact would be significant.

CP3 includes a dam raise of 18.5 feet. This impact would be similar to Impact AQ-1 (CP1) as the same type of construction equipment and activities would be involved. Emissions were calculated as described above in Section 5.3.1, "Methods and Assumptions." The results are shown in Table 5-6 for individual project elements. (All air quality modeling inputs and outputs for the CPs are presented in Attachment 1 to the *Air Quality and Climate Technical Report*.) As shown in Table 5-10 (similar to CP1), ROG, NO_x, and PM emissions for several of the individual project elements could exceed applicable Shasta County thresholds, which would result in a significant impact. As shown in Figures 5-2 to 5-8, maximum daily emissions (lb/day) for CP3 (similar to CP1), could reach much higher levels based on the worst-case simultaneous construction of project elements as shown in detail in Attachment 1 to the *Air Quality and Climate Change Technical Report*. For the same reasons as described for CP1, this impact would be significant. Mitigation for this impact is proposed in Section 5.3.5.

Table 5-10. Summary of Daily Short-Term Construction-Generated Emissions by Project Element (Pounds per Day) – CP3 [1]

Project Element for 18.5-Foot Raise (Activities)	ROG	NO_x	PM_{10} Exh.	PM_{10} Dust	$PM_{2.5}$ Exh.	$PM_{2.5}$ Dust	CO
UPRR Doney Creek Bridge	20	140	8	34	7	5	82
Left Wing Dam	18	138	7	165	6	18	106
Main Concrete Dam	20	138	8	26	2	4	90
Outlet Works	13	138	5	26	5	4	53
Pit River Bridge Pier 3 and 4 Protection	15	138	6	26	5	4	66
Powerplant and Penstocks	12	138	4	26	4	4	48
Railroad Realignment	12	138	4	159	4	17	53
Right Wing Dam	11	138	3	54	3	7	45
Sacramento River UPRR 2nd Crossing	28	141	12	35	11	5	121
Spillway	27	139	11	26	10	4	113
TCD Modifications	20	138	8	26	8	4	82
Visitor Center Replacement	10	138	3	43	3	6	41
Vehicular Bridges	24	155	10	34	9	5	110
Reservoir Clearing	35	260	12	27	11	4	112
Dikes	28	138	12	902	11	91	100
Buildings/Facilities – Recreation	40	141	20	1,483	18	150	166
Roads [2]	28	138	12	588	11	60	102
Utilities	18	138	7	26	6	4	70

Notes:
[1] Totals may not add due to rounding
[2] Quantities modeled are greater than Environmental Impact Statement road quantities

Key:
CO = carbon monoxide
CP = Comprehensive Plan
Exh.= exhaust
NO_X = oxides of nitrogen
$PM_{2.5}$ = fine particulate matter
PM_{10} = respirable particulate matter
ROG = reactive organic gases
TCD = temperature control device
UPRR = Union Pacific Railroad

Impact AQ-2 (CP3): Long-Term Emissions of Criteria Air Pollutants and Precursors During Project Operation Long-term project operation is not anticipated to result in ROG, NO_X, PM_{10}, or CO emissions that exceed applicable SCAQMD thresholds. Thus, long-term operational emissions would not be anticipated to violate an air quality standard or contribute substantially to an existing or projected air quality violation. This impact would be less than significant.

Long-term operational emissions would come from stationary, area, and mobile sources. This impact would be the same as Impact AQ-2 (CP1) for stationary and area sources and similar to Impact AQ-2 (CP1 and CP2) for mobile sources. With CP3, there would be an annual increase of 216,000 and 205,000 visitor days under existing and future conditions, respectively, as was shown in Table 5-5, resulting in 384 and 364 average daily trips under existing and future conditions, respectively. The associated daily emissions are shown in Table 5-11. Overall trip levels would be greater than under CP1 and CP2, but emissions would remain below significance thresholds.

Table 5-11. Operations Emissions for Shasta Dam Raise, 2015 – CP3

Activity	Emissions – pounds per day						
	ROG	NO_x	PM_{10} Exh.	PM_{10} Dust	$PM_{2.5}$ Exh.	$PM_{2.5}$ Dust	CO
Existing Conditions							
Vehicle trips for increase in recreational visitors	2.8	10.0	0.3	5.4	0.3	0.1	21.7
Future Conditions							
Vehicle trips for increase in recreational visitors	2.7	9.5	0.3	5.1	0.3	0.1	20.6

Note:
Totals may not add due to rounding.

Key:
CO = carbon monoxide
CP = Comprehensive Plan
Exh. = exhaust
NO_X = oxides of nitrogen
$PM_{2.5}$ = fine particulate matter
PM_{10} = respirable particulate matter
ROG = reactive organic gases

Based on the above analysis, operation under CP3 would not result in ROG, NO_X, PM_{10}, or CO emissions that exceed SCAQMD Level A thresholds. Consequently, long-term emissions during operation under CP3 would not violate an air quality standard or contribute substantially to an existing or projected air quality violation. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact AQ-3 (CP3): Exposure of Sensitive Receptors to Substantial Pollutant Concentrations Neither short-term construction nor long-term operational sources would expose sensitive receptors to substantial concentrations of CO, PM_{10}, $PM_{2.5}$, or TACs. This impact would be less than significant.

This impact would be the same as Impact AQ-3 (CP1) and would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact AQ-4 (CP3): Exposure of Sensitive Receptors to Odor Emissions
Short-term construction and long-term operational sources would not expose sensitive receptors to substantial odor emissions. This impact would be less than significant.

This impact would be the same as Impact AQ-4 (CP1) and would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Upper Sacramento River (Shasta Dam to Red Bluff)
Impact AQ-5 (CP3): Short-Term Emissions of Criteria Air Pollutants and Precursors Below Shasta Dam During Project Construction Gravel augmentation and habitat restoration in the upper Sacramento River proposed under CP4, CP4A, and CP5 would not be implemented under CP3. No other project construction or long-term operation activities that would affect emissions of criteria air pollutants and precursors are planned in the Shasta Dam-to-Red Bluff area under CP3. Therefore, no impact would occur.

This impact would be the same as Impact AQ-5 (CP1). No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta and CVP/SWP Service Areas No effects on climate and air quality are expected to occur in the lower Sacramento River and Delta and CVP/SWP service areas under CP3; therefore, potential effects in those geographic regions are not discussed further in this EIS.

Global Study Area
Impact AQ-6 (CP3): Generation of Greenhouse Gases Project construction and operational activities would result in emission of a less than significant quantity of GHGs. Overall, implementation of CP3 would result in beneficial effects on GHG emissions because generation of electricity at Shasta Dam would increase. This impact would be less than significant.

This impact would be similar to Impact AQ-6 (CP1) for construction and operations. Based on the modeling conducted, construction of CP3 would result in 4,350 MT CO_2e/year amortized over the project lifetime. GHG emissions of sequestered carbon in removed vegetation were calculated at 7,164 MT CO_2e per year for CP3 (840 acres total). Increased activity by recreational visitors to the Shasta Lake area would result in additional vehicle trips and estimated emissions of 819 and 776 MT CO_2e per year for existing conditions and future conditions, respectively.

For existing conditions, raising Shasta Dam by 18.5 feet and implementing the operational strategy for CP3 would result in a net increase in CVP/SWP power generation of 66 GWh per year, as was shown in Table 5-7. Fossil-fuel generation of 66 GWh of energy would produce an estimated 59,000 MT of CO_2, also shown in Table 5-7. Thus, CP3 would reduce the need to build facilities for fossil-fueled generation of 66 GWh per year in the global study area.

For future conditions, raising Shasta Dam by 18.5 feet and implementing the operational strategy for CP3 would result in a net increase in power generation of 65 GWh per year, as was shown in Table 5-7. Fossil-fuel generation of 65 GWh of energy would produce an estimated 58,100 MT of CO_2, also shown in Table 5-7. Thus, CP3 would reduce the need to build facilities for fossil-fueled generation of 65 GWh per year in the global study area.

Thus, the results of the above analysis show that CP3 would result in short-term emissions of GHG for the years of construction, followed by long-term benefits of GHG reduction through generation of electricity at Shasta Dam. The magnitude of the GHG "savings" for each year of operation would be approximately 46,667 and 45,810 MT CO_2e for existing conditions and future conditions, respectively, considering construction emissions amortized over the project lifetime. The GHG emissions from construction activities would be temporary in duration and mitigated to the extent feasible; therefore, such emissions would not conflict with State or regional planning efforts or emit GHG in excess of mandatory reporting standards. GHG emissions from long-term operations would likely have a net benefit as a result of increased hydroelectric generation and would thus also not conflict with planning efforts or mandatory reporting thresholds. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CP4 and CP4A – 18.5-Foot Dam Raise, Anadromous Fish Focus with Water Supply Reliability

Shasta Lake and Vicinity

Impact AQ-1 (CP4 and CP4A): Short-Term Emissions of Criteria Air Pollutants and Precursors at Shasta Lake and Vicinity During Project Construction
Project construction could result in short-term emissions (e.g., ROG, NO_x, and PM) that exceed applicable SCAQMD thresholds. This conclusion is based on detailed calculations of estimated emissions for project elements and the simultaneous occurrence thereof. Shasta County is a nonattainment area for the State ozone and PM_{10} standards. Thus, short-term emissions generated during construction could contribute substantially to an existing or projected air quality violation. This impact would be significant for CP4 or CP4A.

CP4 and CP4A include a dam raise of 18.5 feet. The impact for CP4 or CP4A would be similar to Impact AQ-1 (CP1) as the same type of construction equipment and activities would be involved. Emissions were calculated as described above in Section 5.3.1, "Methods and Assumptions." The results are shown in Table 5-12 for individual project elements. (All air quality modeling inputs and outputs for the CPs are presented in Attachment 1 to the *Air Quality and Climate Technical Report*.) As shown in Table 5-12 (similar to CP1), ROG, NO_x, and PM emissions for several of the individual project elements could exceed applicable Shasta County thresholds, which would result in a significant impact. As shown in Figures 5-2 to 5-8, maximum daily emissions (lb/day) for CP4 or CP4A (similar to CP1), could reach much higher levels based on the worst-case simultaneous construction of project elements as shown in detail in Attachment 1 to the *Air Quality and Climate Change Technical Report*.

For the same reasons as described for CP1, this impact would be significant for CP4. Mitigation for this impact is proposed in Section 5.3.5.

For the same reasons as described for CP1, this impact would be significant for CP4A. Mitigation for this impact is proposed in Section 5.3.5.

Table 5-12. Summary of Daily Short-Term Construction-Generated Emissions by Project Element (Pounds per Day) – CP4 and CP4A[1]

Project Element for 18.5-Foot Raise (Activities)	ROG	NOx	PM_{10} Exh.	PM_{10} Dust	$PM_{2.5}$ Exh.	$PM_{2.5}$ Dust	CO
UPRR Doney Creek Bridge	20	140	8	34	7	5	82
Left Wing Dam	18	138	7	165	6	18	106
Main Concrete Dam	20	138	8	26	2	4	90
Outlet Works	13	138	5	26	5	4	53
Pit River Bridge Pier 3 and 4 Protection	15	138	6	26	5	4	66
Powerplant and Penstocks	12	138	4	26	4	4	48
Railroad Realignment	12	138	4	159	4	17	53
Right Wing Dam	11	138	3	54	3	7	45
Sacramento River UPRR 2nd Crossing	28	141	12	35	11	5	121
Spillway	27	139	11	26	10	4	113
TCD Modifications	20	138	8	26	8	4	82
Visitor Center Replacement	10	138	3	43	3	6	41
Vehicular Bridges	24	155	10	34	9	5	110
Reservoir Clearing	35	260	12	27	11	4	112
Dikes	28	138	12	902	11	91	100
Buildings/Facilities – Recreation	40	141	20	1,483	18	150	166
Roads[2]	28	138	12	588	11	60	102
Utilities	18	138	7	26	6	4	70
Gravel Augmentation	11	184	3	35	3	5	46
Restore Riparian and Floodplain Habitat	35	185	15	34	14	5	125

Notes:
[1] Totals may not add due to rounding
[2] Quantities modeled are greater than Environmental Impact Statement road quantities

Key:
CO = carbon monoxide
CP = Comprehensive Plan
Exh.= exhaust
NO_X = oxides of nitrogen
$PM_{2.5}$ = fine particulate matter
PM_{10} = respirable particulate matter
ROG = reactive organic gases
TCD = temperature control device
UPRR = Union Pacific Railroad

Impact AQ-2 (CP4 and CP4A): Long-Term Emissions of Criteria Air Pollutants and Precursors During Project Operation Long-term project operation is not anticipated to result in ROG, NO_X, PM_{10}, or CO emissions that exceed applicable SCAQMD thresholds. Thus, long-term operational emissions would not be anticipated to violate an air quality standard or contribute substantially to an existing or projected air quality violation. This impact would be less than significant for CP4 or CP4A.

Long-term operational emissions would come from stationary, area, and mobile sources. This impact would be similar to AQ-2 (CP1) for stationary, area, and mobile sources. With CP4, there would be an annual increase of 363,000 and 370,000 visitor days under existing and future conditions, respectively, as shown in Table 5-5, resulting in 646 and 658 average daily trips under existing and future conditions, respectively. The associated daily emissions are shown in Table 5-13. Overall trip levels would be greater than under CP1 and CP2, but emissions would remain below significance thresholds.

Table 5-13. Operations Emissions for Shasta Dam Raise, 2015 – CP4 and CP4A

Activity	Emissions—pounds per day						
	ROG	NO_x	PM_{10} Exh.	PM_{10} Dust	$PM_{2.5}$ Exh.	$PM_{2.5}$ Dust	CO
CP4							
Existing Conditions							
Vehicle trips for increase in recreational visitors	4.8	16.8	0.5	9.0	0.5	0.1	36.5
Future Conditions							
Vehicle trips for increase in recreational visitors	4.9	17.1	0.5	9.2	0.5	0.1	37.2
CP4A							
Existing Conditions							
Vehicle trips for increase in recreational visitors	4.1	14.2	0.4	7.6	0.4	0.1	31.0
Future Conditions							
Vehicle trips for increase in recreational visitors	3.4	12.0	0.4	1.7	0.3	0.1	26.0

Note:
Totals may not add due to rounding.

Key:
CO = carbon monoxide
CP = Comprehensive Plan
Exh. = exhaust
NO_X = oxides of nitrogen
$PM_{2.5}$ = fine particulate matter
PM_{10} = respirable particulate matter
ROG = reactive organic gases

Based on the above analysis, operation under CP4 would not result in ROG, NO_X, PM_{10}, or CO emissions that exceed SCAQMD Level A thresholds. Consequently, long-term emissions during operation under CP4 would not violate an air quality standard or contribute substantially to an existing or projected air quality violation. This impact would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

Operation under CP4A would not result in ROG, NO_X, PM_{10}, or CO emissions that exceed SCAQMD Level A thresholds. With CP4A, there would be an annual increase of 308,000 and 259,000 visitor days under existing and future conditions, respectively, as shown in Table 5-5, resulting in 548 and 460 average daily trips under existing and future conditions, respectively. The associated daily emissions are shown in Table 5-13. Overall trip levels would be greater than under CP1 and CP2, but emissions would remain below significance thresholds. Consequently, long-term emissions during operation under CP4A would not violate an air quality standard or contribute substantially to an existing or projected air quality violation. This impact would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact AQ-3 (CP4 and CP4A): Exposure of Sensitive Receptors to Substantial Pollutant Concentrations Neither short-term construction nor long-term operational sources would expose sensitive receptors to substantial concentrations of CO, PM_{10}, $PM_{2.5}$, or TACs. This impact would be less than significant for CP4 or CP4A.

This impact would be the same as Impact AQ-3 (CP1) and would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

This impact would be the same as Impact AQ-3 (CP1) and would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact AQ-4 (CP4 and CP4A): Exposure of Sensitive Receptors to Odor Emissions Short-term construction and long-term operational sources would not expose sensitive receptors to substantial odor emissions. This impact would be less than significant for CP4 or CP4A.

This impact would be the same as Impact AQ-4 (CP1) and would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

This impact would be the same as Impact AQ-4 (CP1) and would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact AQ-5 (CP4 and CP4A): Short-Term Emissions of Criteria Air Pollutants and Precursors Below Shasta Dam During Project Construction Gravel augmentation proposed for areas along the upper Sacramento River would add to emissions of ROG, NO_X, and PM_{10} from project construction. Habitat restoration activities proposed for the upper Sacramento River would also add ROG, NO_X, and PM_{10} emissions. However, these emissions separately and combined would add negligible amounts to annual emission levels. This impact would be less than significant for CP4 or CP4A.

Gravel augmentation proposed under CP4 or CP4A would add an additional 1 lb/day of ROG, 16 lb/day of NO_X, and 1 lb/day of PM_{10} to project construction emission levels. Emissions from gravel augmentation would be from gravel material hauling consisting of approximately 18 trips per day, 40 miles round trip to sites identified to the south along the Sacramento River. Gravel augmentation would only occur for 2 months out of the year; therefore, these emissions would add negligible amounts to annual emission levels.

Habitat restoration in the upper Sacramento River proposed under CP4 or CP4A would add an additional 6.7 lb/day of ROG, 50.1 lb/day of NO_X, and 12.4 lb/day of PM_{10} to project construction emission levels. During habitat restoration, emissions would be generated from potentially removing vegetation from the Sacramento River's side channel, removing noxious invasive plant species from the area, minor grading, and hauling away waste materials (approximately 25 trips per day). Restoration activities would occur for only 2 months for a total of 44 8-hour work days; therefore, these emissions would add negligible amounts to annual emission levels.

The combined emissions from gravel augmentation and habitat restoration activities for CP4 or CP4A would be 7.7 lb/day of ROG, 76 lb/day of NO_X, and 13.4 lb/day of PM_{10}. These emissions are below SCAQMD's Level A thresholds of 25 lb/day of ROG, 25 lb/day of NO_X, and 80 lb/day of PM_{10}.

This impact would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

This impact would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta and CVP/SWP Service Areas No effects on climate and air quality are expected to occur in the lower Sacramento River and Delta and CVP/SWP service areas under CP4; therefore, potential effects in those geographic regions are not discussed further in this EIS.

Global Study Area

Impact AQ-6 (CP4 and CP4A): Generation of Greenhouse Gases Project construction and operational activities would result in emission of a less-than-significant quantity of GHGs. Overall, implementation of CP4 or CP4A would result in beneficial effects on GHG emissions because generation of electricity at Shasta Dam would increase. This impact would be less than significant for CP4 or CP4A.

This impact would be similar to Impact AQ-6 (CP1) for construction and operations. Based on the modeling conducted, construction of CP4 or CP4A would result in 5,112 MT CO_2e/year amortized over the project lifetime. GHG emissions of sequestered carbon in removed vegetation were calculated at 7,164 MT CO_2e per year for CP4 and CP4A (840 acres total).

Under CP4, increased activity by recreational visitors to the Shasta Lake area would result in additional vehicle trips and estimated emissions of 1,376 and 1,403 MT CO_2e per year for existing conditions and future conditions, respectively. Under CP4A, increased activity by recreational visitors to the Shasta Lake area would result in additional vehicle trips and estimated emissions of 1,168 and 982 MT CO_2e per year for existing conditions and future conditions, respectively.

For existing conditions under CP4, raising Shasta Dam by 18.5 feet and implementing the operational strategy would result in a net increase in CVP/SWP power generation of 70 GWh per year (Table 5-7). Fossil-fuel generation of 70 GWh of energy would produce an estimated 62,500 MT CO_2 (Table 5-7). Thus, CP4 would reduce the need to build facilities for fossil-fueled generation of 70 GWh per year in the global study area.

For future conditions under CP4, raising Shasta Dam by 18.5 feet and implementing the operational strategy would result in a net increase in CVP/SWP power generation of 64 GWh per year (Table 5-7). Fossil-fuel generation of 64 GWh of energy would produce an estimated 57,100 MT CO_2 (Table 5-7). Thus, CP4 would reduce the need to build facilities for fossil-fueled generation of 64 GWh per year in the global study area.

Thus, the results of the above analysis show that CP4 would result in short-term emissions of GHG for the years of construction, followed by long-term benefits of GHG reduction through generation of electricity at Shasta Dam. The magnitude of the GHG "savings" for each year of operation would be approximately 48,848 and 43,421 MT CO_2e for existing conditions and future conditions, respectively, considering construction emissions amortized over the project lifetime.

For existing conditions under CP4A, raising Shasta Dam by 18.5 feet and implementing the operational strategy would result in a net increase in CVP/SWP power generation of 48 GWh per year (Table 5-7). Fossil-fuel generation of 48 GWh of energy would produce an estimated 42,800 MT CO_2 (Table 5-7). Thus, CP4A would reduce the need to build facilities for fossil-fueled generation of 48 GWh per year in the global study area.

For future conditions under CP4A, raising Shasta Dam by 18.5 feet and implementing the operational strategy would result in a net increase in CVP/SWP power generation of 33 GWh per year (Table 5-7). Fossil-fuel generation of 33 GWh of energy would produce an estimated 29,400 MT CO_2 (Table 5-7). Thus, CP4A would reduce the need to build facilities for fossil-fueled generation of 33 GWh per year in the global study area.

Thus, the results of the above analysis show that CP4A would result in short-term emissions of GHG for the years of construction, followed by long-term benefits of GHG reduction through generation of electricity at Shasta Dam. The magnitude of the GHG "savings" for each year of operation would be approximately 29,356 and 16,142 MT CO_2e for existing conditions and future conditions, respectively, considering construction emissions amortized over the project lifetime.

In conclusion, under both CP4 and CP4A, the GHG emissions from construction activities would be temporary in duration and mitigated to the extent feasible; therefore, such emissions would not conflict with State or regional planning efforts or emit GHG in excess of mandatory reporting standards. GHG emissions from long-term operations would likely have a net benefit as a result of increased hydroelectric generation and would thus also not conflict with planning efforts or mandatory reporting thresholds. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CP5 – 18.5-Foot Dam Raise, Combination Plan

Shasta Lake and Vicinity

Impact AQ-1 (CP5): Short-Term Emissions of Criteria Air Pollutants and Precursors at Shasta Lake and Vicinity During Project Construction Project construction could result in short-term emissions (e.g., ROG, NO_x, and PM) that exceed applicable SCAQMD thresholds. This conclusion is based on detailed calculations of estimated emissions for project elements and the simultaneous occurrence thereof. Shasta County is a nonattainment area for the State ozone and PM_{10} standards. Thus, short-term emissions generated during construction could contribute substantially to an existing or projected air quality violation. This impact would be significant.

CP5 includes a dam raise of 18.5 feet. This impact would be similar to Impact AQ-1 (CP1) as the same type of construction equipment and activities would be involved. Emissions were calculated as described above in Section 5.3.1, "Methods and Assumptions." The results are shown in Table 5-14 for individual project elements. (All air quality modeling inputs and outputs for the CPs are presented in Attachment 1 to the *Air Quality and Climate Technical Report*.) As shown in Table 5-14 (similar to CP1), ROG, NO_x, and PM emissions for several of the individual project elements could exceed applicable Shasta County thresholds, which would result in a significant impact. As shown in Figures 5-2 to 5-8, maximum daily emissions (lb/day) for CP5 (similar to CP1), could reach much higher levels based on the worst-case simultaneous construction of project elements as shown in detail in Attachment 1 to the *Air Quality and Climate Change Technical Report*. For the same reasons as described for CP1, this impact would be significant. Mitigation for this impact is proposed in Section 5.3.5.

Table 5-14. Summary of Daily Short-Term Construction-Generated Emissions by Project Element (Pounds per Day) – CP5[1]

Project Element for 18.5-Foot Raise (Activities)	ROG	NO_x	PM_{10} Exh.	PM_{10} Dust	$PM_{2.5}$ Exh.	$PM_{2.5}$ Dust	CO
UPRR Doney Creek Bridge	20	140	8	34	7	5	82
Left Wing Dam	18	138	7	165	6	18	106
Main Concrete Dam	20	138	8	26	2	4	90
Outlet Works	13	138	5	26	5	4	53
Pit River Bridge Pier 3 and 4 Protection	15	138	6	26	5	4	66
Powerplant and Penstocks	12	138	4	26	4	4	48
Railroad Realignment	12	138	4	159	4	17	53
Right Wing Dam	11	138	3	54	3	7	45
Sacramento River UPRR 2nd Crossing	28	141	12	35	11	5	121
Spillway	27	139	11	26	10	4	113
TCD Modifications	20	138	8	26	8	4	82
Visitor Center Replacement	10	138	3	43	3	6	41
Vehicular Bridges	24	155	10	34	9	5	110
Reservoir Clearing	35	260	12	27	11	4	112
Dikes	28	138	12	902	11	91	100
Buildings/Facilities – Recreation	40	141	20	1,483	18	150	166
Roads[2]	28	138	12	588	11	60	102
Utilities	18	138	7	26	6	4	70
Gravel Augmentation	11	184	3	35	3	5	46
Restore Riparian and Floodplain Habitat	35	185	15	34	14	5	125
Recreation Facilities Enhancement	12	187	3	35	3	5	47
Shoreline Enhancement & Tributary Aquatic Habitat Enhancement	34	187	16	887	15	90	168

Notes:
[1] Totals may not add due to rounding
[2] Quantities modeled are greater than Environmental Impact Statement road quantities

Key:
CO = carbon monoxide
CP = Comprehensive Plan
Exh.= exhaust
NO_X = oxides of nitrogen
$PM_{2.5}$ = fine particulate matter
PM_{10} = respirable particulate matter
ROG = reactive organic gases
TCD = temperature control device
UPRR = Union Pacific Railroad

Impact AQ-2 (CP5): Long-Term Emissions of Criteria Air Pollutants and Precursors During Project Operation Long-term project operation is not anticipated to result in ROG, NO_X, PM_{10}, or CO emissions that exceed applicable SCAQMD thresholds. Thus, long-term operational emissions would not be anticipated to violate an air quality standard or contribute substantially to an existing or projected air quality violation. This impact would be less than significant.

Long-term operational emissions would come from stationary, area, and mobile sources. This impact would be similar to AQ-2 (CP1) for stationary, area, and mobile sources. With CP5 there would be an annual increase of 199,000 and 175,000 visitor days under existing and future conditions, respectively, as shown in Table 5-5, resulting in 354 and 311 average daily trips under existing and future conditions, respectively. The associated daily emissions are shown in Table 5-15.

Table 5-15. Operations Emissions for Shasta Dam Raise, 2015 – CP5

Activity	Emissions—pounds per day						
	ROG	NO_x	PM_{10} Exh.	PM_{10} Dust	$PM_{2.5}$ Exh.	$PM_{2.5}$ Dust	CO
Existing Conditions							
Vehicle trips for increase in recreational visitors	2.6	9.2	0.3	5.0	0.3	0.1	20.0
Future Conditions							
Vehicle trips for increase in recreational visitors	2.3	8.1	0.3	4.4	0.3	0.1	17.6

Note: Totals may not add due to rounding.

Key:
CO = carbon monoxide
CP = Comprehensive Plan
Exh. = exhaust
NO_X = oxides of nitrogen
$PM_{2.5}$ = fine particulate matter
PM_{10} = respirable particulate matter
ROG = reactive organic gases

Based on the above analysis, operation under CP5 would not result in ROG, NO_X, PM_{10}, or CO emissions that exceed SCAQMD Level A thresholds. Consequently, long-term emissions during operation under CP5 would not violate an air quality standard or contribute substantially to an existing or projected air quality violation. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact AQ-3 (CP5): Exposure of Sensitive Receptors to Substantial Pollutant Concentrations Neither short-term construction nor long-term operational sources would expose sensitive receptors to substantial concentrations of CO, PM_{10}, $PM_{2.5}$, or TACs. This impact would be less than significant.

This impact would be the same as Impact AQ-3 (CP1) and would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact AQ-4 (CP5): Exposure of Sensitive Receptors to Odor Emissions Short-term construction and long-term operational sources would not expose sensitive receptors to substantial odor emissions. This impact would be less than significant.

This impact would be the same as Impact AQ-4 (CP1) and would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Upper Sacramento River (Shasta Dam to Red Bluff)
Impact AQ-5 (CP5): Short-Term Emissions of Criteria Air Pollutants and Precursors Below Shasta Dam During Project Construction The gravel augmentation proposed for areas along the upper Sacramento River would add to emissions of ROG, NO_X, and PM_{10} from project construction. However, these emissions would add negligible amounts to annual emission levels. This impact would be less than significant.

This impact would be the same as Impact AQ-5 (CP4) and would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta and CVP/SWP Service Areas No effects on climate and air quality are expected to occur in the lower Sacramento River and Delta and CVP/SWP service areas under CP5; therefore, potential effects in those geographic regions are not discussed further in this EIS.

Global Study Area
Impact AQ-6 (CP5): Generation of Greenhouse Gases Project construction and operational activities would result in emission of a less than significant quantity of GHGs. Overall, implementation of CP5 would result in beneficial effects on GHG emissions because generation of electricity at Shasta Dam would increase. This impact would be less than significant.

This impact would be similar to Impact AQ-6 (CP1) for construction and operations. Based on the modeling conducted, construction of CP5 would result in 5,199 MT CO_2e/year amortized over the project lifetime. GHG emissions of sequestered carbon in removed vegetation were calculated at 7,164 MT CO_2e per year for CP5 (840 acres total). Increased activity by recreational visitors to the Shasta Lake area would result in additional vehicle trips and estimated emissions of 754 MT CO_2e per year.

For existing conditions, raising Shasta Dam by 18.5 feet and implementing the operational strategy for CP5 would result in a net increase in CVP/SWP power generation of 21 GWh per year, as was shown in Table 5-7. Fossil fuel generation of 21 GWh of energy would produce an estimated 18,700 MT CO_2, also shown in Table 5-7. Thus, CP5 would reduce the need to build facilities for fossil-fueled generation of 21 GWh per year in the global study area.

For future conditions, raising Shasta Dam by 18.5 feet and implementing the operational strategy for CP5 would result in a net increase in CVP/SWP power generation of 1 GWh per year, as was shown in Table 5-7. Fossil fuel generation of 1 GWh of energy would produce an estimated 900 MT CO_2, also shown in Table 5-7. Thus, CP5 would reduce the need to build facilities for fossil-fueled generation of 1 GWh per year in the global study area.

Thus, the results of the above analysis show that CP5 would result in short-term emissions of GHG for the years of construction, followed by long-term benefits of GHG reduction through generation of electricity at Shasta Dam for existing conditions. The magnitude of the GHG "savings" for each year of operation would be approximately 5,583 MT CO_2e for existing conditions and a GHG "deficit" of 12,126 MT CO_2e for future conditions considering construction emissions amortized over the project lifetime. The GHG emissions from construction activities would be temporary in duration and mitigated to the extent feasible; therefore, such emissions would not conflict with State or regional planning efforts or emit GHG in excess of mandatory reporting standards. GHG emissions from long-term operations would likely not conflict with planning efforts or mandatory reporting thresholds. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

5.3.5 Mitigation Measures

Table 5-16 presents a summary of mitigation measures for air quality and climate.

Table 5-16. Summary of Mitigation Measures for Air Quality and Climate Change

		No-Action Alternative	CP1	CP2	CP3	CP4	CP4A	CP5
Impact AQ-1: Short-Term Emissions of Criteria Air Pollutants and Precursors at Shasta Lake and Vicinity During Project Construction	LOS before Mitigation	NI	S	S	S	S	S	S
	Mitigation Measure	None required.	Mitigation Measure AQ-1: Implement Standard Measures and Best Available Mitigation Measures to Reduce Emissions Levels.					
	LOS after Mitigation	NI	SU	SU	SU	SU	SU	SU
Impact AQ-2: Long-Term Emissions of Criteria Air Pollutants and Precursors During Project Operation	LOS before Mitigation	LTS	LTS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.					
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS	LTS
Impact AQ-3: Exposure of Sensitive Receptors to Substantial Pollutant Concentrations	LOS before Mitigation	NI	LTS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.					
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS	LTS
Impact AQ-4: Exposure of Sensitive Receptors to Odor Emissions	LOS before Mitigation	NI	LTS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.					
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS	LTS
Impact AQ-5: Short-Term Emissions of Criteria Air Pollutants and Precursors Below Shasta Dam During Project Construction	LOS before Mitigation	NI	NI	NI	NI	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.					
	LOS after Mitigation	NI	NI	NI	NI	LTS	LTS	LTS
Impact AQ-6: Generation of Greenhouse Gases	LOS before Mitigation	LTS	LTS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.					
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS	LTS

Key:
CP = Comprehensive Plan
LOS = level of significance
LTS = less than significant
NA = not applicable
NI = no impact
S = significant
SU = significant and unavoidable

No-Action Alternative

No mitigation measures are needed for this alternative.

CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

No mitigation is needed for Impacts AQ-2 (CP1), AQ-3 (CP1), AQ-4 (CP1), AQ-5 (CP1), and AQ-6 (CP1). Mitigation is provided below for the remaining impact of CP1 on air quality.

Mitigation Measure AQ-1 (CP1): Implement Standard Measures and Best Available Mitigation Measures to Reduce Emissions Levels Reclamation (referred to below as "the project applicant" or "the applicant") and its primary construction contractor(s) will implement the mitigation measures listed below to reduce emissions of criteria air pollutants and precursors generated during construction. In addition, any reasonable Best Management Practices recommended by SCAQMD during construction permitting would be implemented by Reclamation and its primary construction contractor(s).

Standard Mitigation Measures The following SCAQMD SMMs are applicable to all projects.

PM_{10} Controls

- Alternatives to open burning of vegetative material on the project site shall be used by the project applicant unless otherwise deemed infeasible by SCAQMD. Among suitable alternatives is chipping, mulching, or conversion to biomass fuel.

- The applicant shall be responsible for ensuring that all adequate dust control measures are implemented in a timely and effective manner during all phases of project development and construction.

- All material excavated, stockpiled, or graded shall be sufficiently watered to prevent fugitive PM_{10} dust emissions from leaving the property boundaries and causing a public nuisance or a violation of an ambient air standard. Watering shall occur at least twice daily with complete site coverage, preferably in the mid-morning and after work is completed each day.

- All areas (including unpaved roads) with vehicle traffic shall be watered periodically or dust palliatives applied for stabilization of fugitive PM_{10} dust emissions.

- All on site vehicles shall be limited to a speed of 20 miles per hour on unpaved roads developed for construction.

- All land clearing, grading, earthmoving, or excavation activities on a project shall be evaluated and suspended when winds exceed 20 miles per hour if particulate matter becomes airborne.

- All inactive portions of the development site shall be seeded and watered until a suitable grass cover is established.

- The applicant shall be responsible for applying Shasta County Department of Public Works-approved nontoxic soil stabilizers (according to manufacturers' specifications) to all inactive construction areas (previously graded areas that remain inactive for 96 hours) in accordance with the Shasta County Grading Ordinance.

- All trucks hauling dirt, sand, soil, or other loose material shall be covered or maintain at least 2 feet of freeboard (i.e., minimum vertical distance between top of the load and the trailer) in accordance with the requirements of California Vehicle Code Section 23114. This provision shall be enforced by local law enforcement agencies.

- All material transported off site shall be either sufficiently watered or securely covered to prevent a public nuisance.

- During initial grading, earthmoving, or site preparation, the project shall be required to construct a paved (or dust palliative-treated) apron, at least 100 feet in length, onto the project site from the adjacent paved road(s).

- Paved streets adjacent to the development site shall be swept or washed at the end of each day to remove excessive accumulations of silt and/or mud that may have accumulated as a result of activities on the development site.

- Adjacent paved streets shall be swept (water sweeper with reclaimed water recommended) at the end of each day if substantial volumes of soil materials have been carried onto adjacent public paved roads from the project site.

- Wheel washers shall be installed where project vehicles and/or equipment enter and/or exit onto paved streets from unpaved roads. Vehicles and/or equipment shall be washed before each trip.

- Before final occupancy, the applicant shall reestablish ground cover on the construction site through seeding and watering in accordance with the Shasta County Grading Ordinance.

Streets

- The project shall provide for temporary traffic control as appropriate during all phases of construction to improve traffic flow as deemed appropriate by the Shasta County Department of Public Works and/or the California Department of Transportation.

- Construction activities shall be scheduled that direct traffic flow to off-peak hours as much as practicable.

Energy Conservation For any new or relocated structures, the following features will be incorporated as much as practicable:

- The project shall provide for the use of energy-efficient lighting, including controls, and process systems such as water heaters, furnaces, and boiler units.

- The project shall use a central water heating system featuring the use of low-NO_X hot water heaters.

Best Available Mitigation Measures None of the SCAQMD BAMMs are appropriate for the project. Therefore, the following measures will be incorporated into the project:

- The project applicant will prepare and submit to SCAQMD for approval a plan demonstrating that the heavy-duty (equal to or greater than 50 horsepower) off-road vehicles to be used in the construction project, including owned, leased, and subcontractor vehicles, shall achieve a project-wide fleet-average 20 percent NO_X reduction and 45 percent particulate reduction compared to the most recent ARB fleet average at time of construction. Acceptable options for reducing emissions may include use of late-model engines, low-emission diesel products, alternative fuels, engine retrofit technology, after-treatment products, and/or other options as they become available.

- The project applicant will locate all construction equipment maintenance and staging areas at the farthest distance possible from nearby sensitive land uses.

- Idling of diesel-powered vehicles and equipment will not be permitted during periods of nonactive vehicle use. Diesel-powered engines will not be allowed to idle for more than 5 consecutive minutes in a 60-minute period when the equipment is not in use, occupied by an operator, or otherwise in motion, except under the following conditions:

- When equipment is forced to remain motionless because of traffic conditions or mechanical difficulties over which the operator has no control
- When it is necessary to operate auxiliary systems installed on the equipment, only when such system operation is necessary to accomplish the intended use of the equipment
- To bring the equipment to the manufacturer's recommended operating temperature
- When the ambient temperature is below 40ºF or above 85ºF
- When equipment is being repaired

Implementation of the above mitigation measure would reduce ROG, NO_X, and PM_{10} emissions from on-site heavy-duty equipment exhaust by approximately 5 percent, 20 percent, and 45 percent, respectively, and fugitive PM_{10} dust emissions by 75 percent. However, NO_X emissions generated during construction would still exceed the SCAQMD Level B threshold of 137 lb/day. Thus, this impact would be significant and unavoidable.

CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

No mitigation is needed for Impacts AQ-2 (CP2), AQ-3 (CP2), AQ-4 (CP2), AQ-5 (CP2), and AQ-6 (CP2). Mitigation is provided below for the remaining impact of CP2 on air quality.

Mitigation Measure AQ-1 (CP2): Implement Standard Measures and Best Available Mitigation Measures to Reduce Emissions Levels This mitigation measure is identical to Mitigation Measure AQ-1 (CP1). For the reasons described above under Mitigation Measure AQ-1 (CP1), this impact would be significant and unavoidable.

CP3 – 18.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply

No mitigation is needed for Impacts AQ-2 (CP3), AQ-3 (CP3), AQ-4 (CP3), AQ-5 (CP3), and AQ-6 (CP3). Mitigation is provided below for the remaining impact of CP3 on air quality.

Mitigation Measure AQ-1 (CP3): Implement Standard Measures and Best Available Mitigation Measures to Reduce Emissions Levels This mitigation measure is identical to Mitigation Measure AQ-1 (CP1). For the reasons described above under Mitigation Measure AQ-1 (CP1), this impact would be significant and unavoidable.

CP4 and CP4A – 18.5-Foot Dam Raise, Anadromous Fish Focus with Water Supply Reliability

No mitigation is needed for Impacts AQ-2 (CP4 and CP4A), AQ-3 (CP4 and CP4A), AQ-4 (CP4 and CP4A), AQ-5 (CP4 and CP4A), and AQ-6 (CP4 and CP4A). Mitigation is provided below for the remaining impact of CP4 and CP4A on air quality.

Mitigation Measure AQ-1 (CP4 and CP4A): Implement Standard Measures and Best Available Mitigation Measures to Reduce Emissions Levels This mitigation measure is identical to Mitigation Measure AQ-1 (CP1). For the reasons described above under Mitigation Measure AQ-1 (CP1), this impact would be significant and unavoidable.

CP5 – 18.5-Foot Dam Raise, Combination Plan

No mitigation is needed for Impacts AQ-2 (CP5), AQ-3 (CP5), AQ-4 (CP5), AQ-5 (CP5), and AQ-6 (CP5). Mitigation is provided below for the remaining impact of CP5 on air quality.

Mitigation Measure AQ-1 (CP5): Implement Standard Measures and Best Available Mitigation Measures to Reduce Emissions Levels This mitigation measure is identical to Mitigation Measure AQ-1 (CP1). For the reasons described above under Mitigation Measure AQ-1 (CP1), this impact would be significant and unavoidable.

5.3.6 Cumulative Effects

Chapter 3, “Considerations for Describing the Affected Environment and Environmental Consequences,” discusses overall cumulative impacts methodology related to the action alternatives, including the relationship to the CALFED Bay-Delta Program Programmatic EIS/EIR cumulative impacts analysis, qualitative and quantitative assessment, past and future actions in the study area, and significance criteria. Table 3-1, “Present and Reasonably Foreseeable Future Actions Included in the Analysis of Cumulative Impacts, by Resource Area,” lists the present and reasonably foreseeable future projects considered quantitatively and qualitatively within the cumulative impacts analysis. The action alternatives would not combine with any of the quantitatively assessed projects listed in Table 3-1 to have a cumulatively considerable impact on air quality or climate change; therefore, this section evaluates only those projects listed in Table 3-1 that are qualitatively considered in this EIS.

Past impacts on air quality and GHG include land use changes, construction, fossil fuel uses, and transportation emissions. Reasonably foreseeable future projects in the primary study that may affect air quality and GHG include the Moody Flats Quarry, the Mountain Gate at Shasta Mixed-Use Area Plan and the Antlers Bridge Replacement.

The effects of climate change on operations at Shasta Lake could potentially result in changes downstream. As described in the Climate Change Appendix, climate change could result in higher reservoir releases in the future due to an increase in winter and early spring inflow into the lake from high intensity storm events. The change in reservoir releases could be necessary to manage for flood events resulting from these potentially larger storms. The potential increase in releases from the reservoir could lead to long-term changes in downstream channel equilibrium.

Growth is likely to continue to occur throughout the primary and extended study areas and some future projects that could generate emissions are reasonably foreseeable, but emissions associated with these projects would be associated primarily with short-term construction activities that would cease once the projects are complete. In addition, emissions associated with one or a few projects would not be considered substantial such that a cumulative impact would occur to a cumulative, global issue such as climate change. Thus, increases in emissions of criteria air pollutants or precursors in the primary and extended study areas are unlikely to make a cumulatively considerable contribution to an overall cumulatively significant impact on air quality. For cumulative effects of climate change on other resource areas, please see the “Cumulative Effects” sections in other chapters of this EIS.

Shasta Lake and Vicinity and Upper Sacramento River (Shasta Dam to Red Bluff)

Under the project alternatives (CP1 – CP5), construction activities would result in short-term emissions of ROG, NO_X, and PM_{10} that without mitigation would exceed applicable SCAQMD thresholds. After implementing the best available and all feasible mitigation measures, ROG and PM_{10} emissions would not exceed applicable thresholds; and in combination with past, present, and reasonably foreseeable future projects, would not result in an overall cumulatively significant impact. Therefore, with mitigation, these emissions would not be cumulatively considerable. Emissions of NO_X, however, would still exceed the applicable SCAQMD threshold after implementation of the BAMMs. These emissions would be cumulatively considerable, and this would be a cumulatively significant and unavoidable impact.

Operation of any of the action alternatives would not result in cumulatively considerable emissions of ROG, NO_X, and PM_{10}. Also, neither short-term construction nor long-term operational sources would expose sensitive receptors to substantial concentrations of CO, PM_{10}, $PM_{2.5}$, TACs, or odors. None of these emissions would be cumulatively considerable contributions to a significant cumulative impact of ROG, NO_X, and PM_{10}.

Lower Sacramento River and Delta and CVP/SWP Service Areas

The project alternatives would not generate any short-term or long-term air pollutant emissions in the extended study area. Therefore, there would be no cumulative air quality impact.

Global Study Area—Climate Change

As discussed in Section 5.1, "Affected Environment," of this chapter, climate change is a global phenomenon. All GHG emissions are considered cumulative. The impact analyses for Impacts AQ-6 (CP1), AQ-6 (CP2), AQ-6 (CP3), AQ-6 (CP4 and CP4A), and AQ-6 (CP5), in Section 5.3.4, "Direct and Indirect Effects," of this chapter are cumulative analyses. All project alternatives (CP1–CP5) would result in short-term cumulative impacts that would be less than the suggested significance threshold for this cumulative effect, and therefore are considered to not make a cumulatively considerable incremental contribution to a significant cumulative impact, and would have beneficial long-term effects. For cumulative effects of climate change on other resource areas, please see the "Cumulative Effects" sections in other chapters of this EIS.

Chapter 6 Hydrology, Hydraulics, and Water Management

6.1 Affected Environment

This affected environment section first presents background information and then describes storage and diversion facilities, and hydrology, hydraulics, and water management (H&H), including flood management, south Delta water levels, and groundwater resources. For a more in-depth description of the affected environment, see the *Hydrology, Hydraulics, and Water Management Technical Report*.

6.1.1 Storage Facilities

Facilities described below include Shasta Dam and Powerplant, Keswick Dam and Powerplant, and Anderson-Cottonwood Irrigation District Diversion Dam.

Shasta Lake and Vicinity

This section describes storage facilities in the Shasta Lake area.

Shasta Dam and Powerplant Shasta Dam is a curved, gravity-type, concrete structure that rises 533 feet above the streambed with a total height above the foundation of 602 feet. The dam has a crest width of about 41 feet and a length of 3,460 feet. Shasta Reservoir has a storage capacity of 4,550,000 acre-feet, and water surface area at full pool of 29,600 acres. Maximum seasonal flood management storage space in Shasta Reservoir is 1.3 million acre-feet (MAF). Releases from Shasta Dam can be made through the powerplant, over the spillway, or through the river outlets. The powerplant has a maximum release capacity of nearly 20,000 cubic feet per second (cfs), the river outlets can release a maximum of 81,800 cfs at full pool, and the maximum release over the drum-gated spillway is 186,000 cfs.

Upper Sacramento River (Shasta Dam to Red Bluff)

This section describes storage facilities along the Upper Sacramento River.

Keswick Dam and Powerplant Keswick Dam is about 9 miles downstream from Shasta Dam. In addition to regulating outflow from the dam, Keswick Dam controls runoff from 45 square miles of drainage area. Keswick Dam is a concrete, gravity-type structure with a spillway over the center of the dam. The spillway has four 50- by 50-foot fixed wheel gates with a combined discharge capacity of 248,000 cfs at full or full pool elevation (587 feet). Storage capacity below the top of the spillway gates at full pool is 23,800 acre-feet. The powerplant has a nameplate generating capacity of 105,000 kilowatts and can pass about 15,000 cfs at full pool.

6.1.2 Diversion Facilities

In the Klamath Basin, the Clear Creek Tunnel diverts water from Lewiston Reservoir (below Trinity Reservoir) to Whiskeytown Reservoir. The Spring Creek Tunnel then diverts water from Whiskeytown Reservoir to Keswick Reservoir on the Sacramento River. These two diversions bring water from the Klamath Basin into the Sacramento Basin; the water is used for power generation, water temperature regulation and local water supplies.

Below Keswick Dam, two facilities divert flows from the Sacramento River, the Anderson-Cottonwood Irrigation District Diversion Dam and Red Bluff Pumping Plant (RBPP). The primary purpose of these two facilities is to divert water into canals for local agricultural use.

In the Delta, the CVP and SWP primarily make diversions through two pumping plants, the CVP C.W. “Bill” Jones Pumping Plant (Jones) and the SWP Harvey O. Banks Pumping Plant (Banks). These two pumping plants supply water to the CVP/SWP service areas south of the Delta. Although other diversion facilities are located between RBPP and the Delta, they would have less of an effect on project operations than those discussed above.

6.1.3 Hydrology and Hydraulics

The Sacramento Valley contains the Sacramento, Feather, and American river basins, covering an area of more than 24,000 square miles in the northern portion of the Central Valley. The Sacramento Valley comprises four distinct areas; the Sacramento River headwater that includes the McCloud River, Pit River, and Sacramento River in the north; the Delta in the south; the Sierra Nevada Mountains and Cascade Ranges in the east; and the Coast Range and Klamath Mountains in the west.

Shasta Lake and Vicinity

The most northern portion of the Sacramento River basin, upstream from Shasta Dam, is drained by four major tributaries (the Sacramento River, McCloud River, Pit River, and Squaw Creek) in addition to numerous minor tributary creeks and streams.

Upper Sacramento River (Shasta Dam to Red Bluff)

Flows in the Sacramento River in the 65-mile reach between Shasta Dam and Red Bluff (River Mile (RM) 244) are regulated by Shasta Dam and are reregulated downstream at Keswick Dam (RM 302). In this reach, flows are influenced by tributary inflow. Major west side tributaries to the Sacramento River in this reach of the river include Clear and Cottonwood creeks. Major east side tributaries to the Sacramento River in this reach of the river include Battle, Bear, Churn, Cow, and Paynes creeks. This section of the Sacramento River also receives water from Klamath Basin (see Section 6.1.2, “Diversion Facilities).

Lower Sacramento River and Delta

The Sacramento River enters the Sacramento Valley about 5 miles north of Red Bluff. From Red Bluff to Chico Landing (52 miles), the river receives flows from Antelope, Mill, Deer, Big Chico, Rock, and Pine creeks on the east side and Thomes, Elder, Reeds, and Red Bank creeks on the west side. From Chico Landing to Colusa (50 miles), the Sacramento River meanders through alluvial deposits between widely spaced levees. Stony Creek is the only major tributary in this segment of the river. No tributaries enter the Sacramento River between Stony Creek and its confluence with the Feather River.

Floodwaters in the Sacramento River overflow the east bank at three sites in a reach referred to by the State of California (State) as the Butte Basin Overflow Area. In this river reach, several Federal projects begin, including the Sacramento River Flood Control Project, Sacramento River Major and Minor Tributaries Project, and Sacramento River Bank Protection Project. Levees of the Sacramento River Flood Control Project begin in this reach, downstream from Ord Ferry on the west (RM 184), and downstream from RM 176 above Butte City on the east side of the river.

Shasta Reservoir also is operated to meet a flow requirement in the Sacramento River, at Wilkins Slough near Grimes (RM 125), also known as the Navigation Control Point. Downstream from Wilkins Slough, the Feather River, the largest east side tributary to the Sacramento River, enters the river just above Verona. Between Wilkins Slough and Verona, floodwater is diverted at two places in this segment of the river—Tisdale Weir into the Tisdale Bypass and Fremont Weir into the Yolo Bypass. The bypass system routes floodwater away from the mainstem Sacramento River to discharge into the Delta.

Below Verona, the Sacramento River flows 79 miles to the Delta, passing the City of Sacramento. The Yolo Bypass parallels this river reach to the west. Flows enter this river reach at various points. First, flows from the Natomas Cross Canal enter the Sacramento River approximately 1 mile downstream from the Feather River mouth. The American River flows into the Sacramento River in the City of Sacramento. When Sacramento River system flood flows are the highest, a portion of the flow is diverted into the Yolo Bypass at the Sacramento Weir, about 3 miles upstream from the American River confluence in downtown Sacramento. At the downstream end, Yolo Bypass flows reenter the Sacramento River near Rio Vista. As the river enters the Delta, Georgiana Slough branches off from the mainstem of the Sacramento River, routing a portion of the flow into the central Delta.

The hydraulics of the Delta are complicated by tidal influences, a multitude of agricultural and municipal and industrial (M&I) diversions for use within the Delta itself, and by CVP and SWP exports. The principal factors affecting Delta hydrodynamics are (1) river inflow and outflow from the Sacramento River and San Joaquin River systems, (2) daily tidal inflow and outflow through San Francisco Bay, and (3) export pumping from the south Delta, primarily through the Jones and Banks pumping plants.

The Jones Pumping Plant consists of six pumps, with a maximum export capacity of 4,600 cfs. The Jones Pumping Plant is at the end of an earth-lined intake channel about 2.5 miles long.

The Banks Pumping Plant supplies water for the South Bay Aqueduct and the California Aqueduct, with an installed capacity of 10,300 cfs. Under current operational constraints, exports from Banks Pumping Plant generally are limited to a daily average of 6,680 cfs, except between December 15 and March 15, when exports can be increased by 33 percent of San Joaquin River flow. The Banks Pumping Plant exports water from the Clifton Court Forebay, a 31,000-acre-foot reservoir that provides storage for off-peak pumping, and moderates the effect of the pumps on the fluctuation of flow and stage in adjacent Delta channels.

The Contra Costa Water District (CCWD) supplies CVP water to its users via a pumping plant at the end of Rock Slough. The Rock Slough diversion capacity of 350 cfs gradually decreases to 22 cfs at the terminus. CCWD also constructed and operates the 160,000-acre-foot Los Vaqueros Reservoir, which has intakes and pumping plants on the Old River and Victoria Canal for diverting surplus Delta flows to reservoir storage or contract water to CCWD users. Because tidal inflows are approximately equivalent to tidal outflows during each daily tidal cycle, tributary inflows and export pumping are the principal variables that define the range of hydrodynamic conditions in the Delta. Excess outflow occurs almost entirely during the winter and spring months. Average winter outflow is about 32,000 cfs, while the average summer outflow is 6,000 cfs.

CVP/SWP Service Areas

This section describes the hydrology and hydraulics of the CVP/SWP service areas, located south of the primary study area.

Downstream from the Jones Pumping Plant, CVP water flows in the Delta-Mendota Canal and can be either diverted by the O’Neill Pumping-Generating Plant into the O’Neill Forebay or can continue down the Delta-Mendota Canal for delivery to CVP contractors. The O’Neill Pumping-Generating Plant consists of six pump-generating units, with a capacity of 700 cfs each.

The O’Neill Forebay is a joint CVP/SWP facility, with a storage capacity of about 56,000 acre-feet. In addition to its interactions with the Delta-Mendota Canal via the O’Neill Pumping-Generating Plant, it is a part of the SWP California Aqueduct. The O’Neill Forebay serves as a regulatory body for San Luis Reservoir; the William R. Gianelli Pumping-Generating Plant, also a joint CVP/SWP facility, can pump flows from the O’Neill Forebay into San Luis

Reservoir and also make releases from San Luis Reservoir to the O'Neill Forebay for diversion to either the Delta-Mendota Canal or the California Aqueduct. Also, several water districts receive diversions directly from the O'Neill Forebay. The William R. Gianelli Pumping-Generating Plant consists of eight units, with 1,375 cfs of capacity each.

San Luis Reservoir provides offstream storage for excess winter and spring flows diverted from the Delta. It is sized to provide seasonal carryover storage, with a total capacity of 2,027,840 acre-feet. The CVP share of the storage is 965,660 acre-feet; the remaining 1,062,180 acre-feet are the SWP share. During spring and summer, water demands and schedules are greater than the capability of Reclamation and DWR to pump water from the Jones and Banks pumping plants; water stored in San Luis Reservoir is used to make up the difference. The CVP share of San Luis Reservoir typically is at its lowest in August and September, and at its maximum in April. The San Felipe Division of the CVP supplies water to customers in Santa Clara and San Benito counties from San Luis Reservoir. The operation of San Luis Reservoir has the potential to affect the water quality and reliability of these supplies if reservoir storage drops below 300,000 acre-feet.

South of the O'Neill Forebay, the Delta-Mendota Canal terminates in the Mendota Pool, about 30 miles west of Fresno. From the Delta-Mendota Canal, the CVP makes diversions to multiple water users and refuges. Delta-Mendota Canal capacity at the terminus is 3,211 cfs. Parallel to the Delta-Mendota Canal, the San Luis Canal-California Aqueduct is a joint-use facility for the CVP and SWP. It begins on the southeast edge of the O'Neill Forebay and extends about 101.5 miles southeasterly to a point near Kettleman City. Water from the canal serves the San Luis Federal service area, mostly for agricultural purposes and for some M&I uses. The canal has a capacity ranging from 8,350 cfs to 13,100 cfs.

South of Banks Pumping Plant, the California Aqueduct flows into Bethany Reservoir, a 5,000-acre-foot forebay for the South Bay Pumping Plant. Exiting the Bethany Forebay, the California Aqueduct flows through a series of checks to the aforementioned O'Neill Forebay, and is either pumped into San Luis Reservoir or released to the San Luis Canal, the CVP/SWP joint-use portion of the California Aqueduct. Deliveries are made from the California Aqueduct to agricultural and M&I contractors.

Downstream from the pumping plants is the Delta-Mendota Canal/California Aqueduct Intertie, a shared federal-state water system improvement project which connects the Delta-Mendota Canal (federal facility) and the California Aqueduct (state facility) and pumping station and two 108-inch-diameter pipes. The pumping station has a capacity of 467 cfs up hill and 900 cfs gravity flow from the California Aqueduct to the Delta-Mendota Canal. The Intertie is located at the closest point between the Delta-Mendota Canal and California Aqueduct which is 500 feet horizontal and 50 feet vertical. The Intertie provides redundancy in the water distribution system, allows for maintenance and repair activities that are less disruptive to water deliveries, and provides the flexibility to respond to CVP and SWP emergencies.

6.1.4 Surface Water Supply

Although water supply reliability is one of the two primary planning objectives of the SLWRI, operations for Shasta Reservoir primarily are focused on delivering water supply to CVP contractors. However, because of the interconnectivity of the CVP and SWP, water supply operations of the SWP could be affected by changes in operations of the CVP associated with the SLWRI.

CVP/SWP Service Areas

This section describes surface water supply to CVP and SWP contractors.

CVP Contractors At certain times of the year, operations of Shasta Reservoir are driven by water supply needs of the CVP contractors. The CVP provides water to settlement contractors in the Sacramento Valley, exchange contractors in the San Joaquin Valley, agricultural and M&I water service contractors in both the Sacramento and San Joaquin valleys, and wildlife refuges both north and south of the Delta. At the beginning of each year, Reclamation evaluates hydrologic conditions throughout California and uses this information to forecast CVP operations, and to estimate the amount of water to be made available to the Federal water service contractors for the year.

The majority of the Federal water service contractors have service areas located south of the Delta. In general, allocations to CVP water service contractors south of the Delta are lower than allocations to service contractors in the Sacramento Valley. Because of water rights secured before construction of the CVP, Sacramento Valley settlement contractors and San Joaquin Valley exchange contractors have a higher level of reliability for their supplies; except in extremely dry years, when the water year type, as defined by the Shasta Hydrologic Index, is classified as critical, settlement and exchange contractors receive 100 percent of their contract amounts. In Shasta critical years, settlement and exchange contractors receive 75 percent of their contract amounts. A Shasta critical year is defined as a year when the total inflow to Shasta Reservoir is below 3.2 MAF, or the average inflow for a 2-year period is below 4.0 MAF and the total 2-year deficiency for deliveries is higher than 0.8.

SWP Contractors The CVP and SWP are intrinsically linked through the Delta; shared responsibilities under their respective water rights and coordinated operations agreements mean that a change in flow from one project could result in a flow change from the other. Accordingly, SWP water supply operations are discussed below.

The SWP operates under long-term contracts with public water agencies throughout California. These agencies, in turn, deliver water to wholesalers or retailers, or deliver it directly to agricultural and M&I water users (DWR 1999). The SWP contracts between DWR and individual State water contractors define several classifications of water available for delivery under specific circumstances.

6.1.5 Flood Management

This section describes major features of the flood management system in the primary and extended study areas, including reservoirs, levees, weirs, and bypasses. Historical operation of these facilities also is described.

Shasta Lake and Vicinity

Releases from Shasta Dam often are made for flood management. Releases for flood management occur either in the fall, beginning in early October, to reach the prescribed vacant flood space, or to evacuate space during or after a storm event to maintain the prescribed vacant flood space in the reservoir. During a storm event, releases for flood management occur either over the spillway during large events or through river outlets for smaller events. Between 1950 and 2006, flows over the spillway occurred in 12 years, or in 21 percent of years. During the same time interval, releases for flood management (either for seasonal space evacuation or during a flood event, and including spills over the spillway) occurred in about 37 years, or nearly 70 percent of the years.

Upper Sacramento River (Shasta Dam to Red Bluff)

Historically, the largest flood events along the upper Sacramento River have been from heavy rainfall, with a relatively smaller component of the flows coming from snowmelt in the upper basin. Flood management operations at Shasta Dam include forecasting runoff into Shasta Lake as well as runoff of unregulated creek systems downstream from Keswick Dam. A critical component of upper Sacramento River flood operations is the forecast of local runoff entering the Sacramento River between Keswick Dam and Bend Bridge near Red Bluff.

The unregulated creeks (major tributaries include Cottonwood, Cow, and Battle creeks) discharging into the Sacramento River between Keswick Dam and Bend Bridge can produce high runoff rates into the Sacramento River in short periods of time. During large flood events, the local runoff between Keswick Dam and Bend Bridge can exceed 100,000 cfs.

Lower Sacramento River and Delta

Flood management facilities along the lower Sacramento River and in the Delta include the levees, weirs, and bypasses of upper and lower Butte basin, the Sacramento River between Colusa and Verona, and the Sacramento River between Verona and Collinsville. The levees, weirs, and bypasses are features of the Sacramento River Flood Control Project, which began operation in the 1930s and was significantly expanded in the 1950s.

When Sacramento River flows exceed between 90,000 and 100,000 cfs at Ord Ferry, water flows naturally over the banks of the river into Butte basin. In addition to the Sacramento River overbank flows at Ord Ferry, the basin receives inflow over the Colusa and Moulton weirs and from tributary streams draining from the northeast, principally Cherokee Canal and Butte Creek. Before construction of the Feather River levees, Butte basin also received overflows from the Feather River north of the Sutter Buttes. Outflows from Butte basin move through the Sutter Bypass when the Sacramento River is high or through the Butte Slough outfall gates (RM 139) into the Sacramento River when the river is low.

The Sacramento River meanders through the 64 miles between Colusa (RM 143) and Verona (RM 79). The levee system continues along both sides of this river reach. The levee spacing (or channel width), east to west, is wider between the upstream sections, from RM 176 to RM 143 at Colusa, than the levee spacing downstream from Colusa. The Feather River, the largest east side tributary to the Sacramento River, enters the river just above Verona. Flood management diversions occur at two places in this segment of the river, at the Tisdale Weir and Fremont Weir.

Below Verona, the Sacramento River flows 79 miles to Collinsville, at the mouth of the Delta, passing the City of Sacramento along the way. The Yolo Bypass parallels this river reach to the west. Flows enter this river reach at various points. First, flows from the Natomas Cross Canal enter the Sacramento River approximately 1 mile downstream from the Feather River mouth (RM 80). The American River (RM 60), the southernmost major Sacramento River tributary, enters the river at the City of Sacramento. Flows in the Yolo Bypass reenter the river near Rio Vista (RM 12). As the river enters the Delta, Georgiana Slough branches off from the mainstream Sacramento River, routing flows into the central Delta. The one diversion point for flood management is at Sacramento Weir, where floodwaters are diverted from the Sacramento River through the Sacramento Bypass to the Yolo Bypass under the highest flow conditions.

CVP/SWP Service Areas

This section describes flood management facilities in the CVP/SWP service areas by river basin, including the Feather River, American River, San Joaquin River, and east side tributaries to the Delta (i.e., Littlejohns Creek, Calaveras River, and Mokelumne River).

The primary flood management feature of the Feather River basin is Oroville Reservoir, with a flood management reservation volume of 750,000 acre-feet. Oroville Reservoir releases are used to help meet the objective flow on the Feather River of 150,000 cfs, and in conjunction with New Bullards Bar Reservoir on the Yuba River, to meet an objective flow below the Yuba River confluence of 300,000 cfs. Levees line the Feather River from its confluence with the Sacramento River to the City of Oroville (RM 63).

The lower American River is primarily protected from flooding by Folsom Dam. The Folsom Reservoir flood management reservation volume is variable, ranging from 400,000 acre-feet to 670,000 acre-feet. The objective release on the American River is 115,000 cfs; however, some damage to infrastructure along the American River occurs at flows above 20,000 cfs. The American River is leveed from its confluence with the Sacramento River to near the Carmichael Bluffs on the north bank, and to near the Sunrise Boulevard Bridge on the south bank (RM 19).

The San Joaquin River basin is protected by an extensive reservoir system, including the following:

- Friant Dam and Millerton Lake (RM 270), with a flood management reservation volume of 170,000 acre-feet
- Big Creek Dam, on Big Creek, with a flood management reservation of 30,200 acre-feet
- Hidden Dam and Hensley Lake on the Fresno River, with a flood management reservation of 65,000 acre-feet
- Buchanan Dam and H.V. Eastman Lake on the Chowchilla River, with a flood management reservation of 45,000 acre-feet
- Los Banos Detention Dam on Los Banos Creek, with a flood management reservation of 14,000 acre-feet
- Merced County Stream Group Project, consisting of five dry dams (i.e., Bear, Burns, Owens, Mariposa, and Castle) and two diversion structures, with a total flood storage capacity of 30,500 acre-feet
- New Exchequer Dam and Lake McClure on the Merced River, with a flood management reservation of 350,000 acre-feet
- Don Pedro Dam and Lake on the Tuolumne River, with a flood management reservation of 340,000 acre-feet
- New Melones Dam and Lake on the Stanislaus River, with a flood management reservation of 450,000 acre-feet

The streams in the northern portion of the San Joaquin River basin, between the American and Stanislaus rivers, commonly are referred to as the eastside tributaries to the Delta. These rivers flow into the San Joaquin River within the boundaries of the Delta. Flood management features on the eastside tributaries to the Delta include the following:

- Farmington Dam and Reservoir on Littlejohns Creek, with a flood management reservation of 52,000 acre-feet
- New Hogan Dam and Lake on the Calaveras River, with a flood management reservation of 165,000 acre-feet
- Camanche Dam and Reservoir on the Mokelumne River, with a flood management reservation of 200,000 acre-feet

6.1.6 South Delta Water Levels

This section discusses the variability of water levels in the south Delta, as part of CVP/SWP operations in the extended study area.

In the south Delta, decreases in water levels resulting from CVP and SWP export pumping are a concern for local agricultural diverters because, during periods of low water levels, sufficient pump draft cannot be maintained and irrigation can be interrupted. Historically, the highest minimum stage in the Middle River typically occurs in February and is about 0.1 foot below mean sea level (msl). The lowest minimum stage typically occurs in August and is about 0.8 foot below msl. During dry and critical years,[1] under existing conditions, the highest minimum stage in the Middle River typically occurs in April and is about 0.6 foot below msl. The lowest minimum stage typically occurs in September and is about 0.7 foot below msl (CALFED 2000a).

6.1.7 Groundwater Resources

The use and sustainable management of groundwater resources is an important component in meeting water demands in California. More than 70 percent of California’s groundwater extraction occurs in the Central Valley from Tulare Lake, San Joaquin River, and Sacramento River Hydrologic Regions (HR) combined (DWR 2003b). The South Coast, North Coast, North Lahontan, San Joaquin River, and Sacramento River HRs take between 20 and 40 percent of their supply from groundwater. Information specific to groundwater resources includes groundwater levels and budget and groundwater quality.

Shasta Lake and Vicinity

Shasta Lake and vicinity are located in the foothill area northwest of the Redding groundwater basin. Small groundwater basins underlying Shasta Lake and vicinity do not have significant groundwater availability for use as a source of supply (Shasta County Water Agency 1998). Groundwater basins underlying Shasta County include the Fall River Valley groundwater basin, Lake Britton groundwater basin, and North Fork Battle Creek. Of these three groundwater basins, the Fall River Valley groundwater basin covers the largest area (54,800 acres) and groundwater extraction for agricultural use in this basin is the highest (approximately 19,000 acre-feet). Estimated groundwater extraction for M&I

[1] Throughout this document, water year types are defined according to the Sacramento Valley Index Water Year Hydrologic Classification unless specified otherwise.

use in these subbasins ranges from 5 acre-feet to 240 acre-feet. Deep percolation from applied water is minor, ranging from 10 acre-feet to 4,800 acre-feet. Groundwater quality in Shasta Lake and vicinity typically is good. Total dissolved solids (TDS) concentrations in the Fall River Valley groundwater basin are low, ranging from 115 to 232 milligrams per liter (mg/L) and some wells in the area have high iron concentrations (DWR 2003b).

Upper Sacramento River (Shasta Dam to Red Bluff)

The upper Sacramento River portion of the study area extends from Redding to Red Bluff and includes the Redding groundwater basin and the northern portion of the Sacramento groundwater basin.

The Redding groundwater basin underlies most of the upper Sacramento River area between Shasta Dam and Red Bluff. The basin is bordered on the north, east, and west by foothills, and on the south by the Sacramento Valley groundwater basin (Tehama 1996). The foothill areas that constitute the eastern and western portions of Shasta and Tehama counties, adjacent to the Redding groundwater basin, are designated as “highland” areas, noted for their relative scarcity of groundwater resources. DWR Bulletin 118 (2003b) subdivides the Redding groundwater basin into six subbasins: Anderson, Enterprise, Millville, Rosewood, Bowman, and South Battle Creek.

The Sacramento groundwater basin extends from the Redding groundwater basin to the San Joaquin Valley, and includes Tehama, Glenn, Butte, Yuba, Colusa, Placer, and Yolo counties.

In general, groundwater flows southeasterly on the west side of the Redding groundwater basin and southwesterly on the east side, toward the Sacramento River (Reclamation and DWR 2003). DWR conducted a review of groundwater level hydrographs in the Anderson, Enterprise, Millville, Rosewood, and Bowman subbasins where groundwater level data was available. This review illustrated the following trends associated with the 1976-1977 and 1987-1994 droughts in each subbasin, followed by a gradual recovery in levels to pre-drought conditions of the early 1970’s and 1980’s (DWR 2003b).

- Slight decline (Anderson Subbasin),
- Gradual decline of approximately 5- to 10-feet (Enterprise Subbasin),
- Slight decline of approximately 5-feet (Millville Subbasin),
- Slight decline (Rosewood Subbasin),
- Slight decline (Bowman Subbasin)

This review also illustrated generally seasonal fluctuations in groundwater levels in the Anderson, Enterprise, Millville, Rosewood, and Bowman subbasins where groundwater level data was available, within the following ranges:

- Ranges from 1- to 10-feet for normal and dry years (Anderson Subbasin),
- Ranges from 5- to 10-feet and for the semi-confined wells, between 10- to 15-feet for normal and dry years (Enterprise Subbasin),
- Range from 2- to 8-feet for normal and dry years (Millville Subbasin),
- Range from 5- to 10-feet for normal and dry years (Rosewood Subbasin),
- Approximately 5-feet for normal and dry years (Bowman Subbasin).

Historically, groundwater levels in the Redding groundwater basin have remained relatively stable, with no apparent long-term trend of declining or increasing levels. DWR has estimated the total quantity of groundwater storage in the Redding groundwater basin at approximately 6.9 MAF (Reclamation and DWR 2003).

In the northern portion of the Sacramento groundwater basin, the following three subbasins are included in upper Sacramento River portion of the primary study area: Red Bluff, Antelope, and Bend subbasins. Groundwater extraction in the Red Bluff subbasin is nearly 90,000 acre-feet. DWR reported that Red Bluff, Corning, Woodland, Davis, and Dixon are completely dependent on groundwater. Domestic use of groundwater varies, but in general, rural unincorporated areas rely completely on groundwater (DWR 2003b).

Groundwater in the Redding area is of good quality, as shown by low TDS concentrations, ranging from 70 to 360 mg/L within the six Redding Groundwater Basin subbasins (DWR 2003b). This range is below the U.S. Environmental Protection Agency and California Environmental Protection Agency secondary drinking water standard of 500 mg/L, and also below the agricultural water quality goal of 450 mg/L. Areas of high salinity and poor quality are generally found on the basin margins where groundwater is derived from marine sedimentary rock containing brackish to saline water (Reclamation and DWR 2003). The groundwater is degraded by underlying marine sediments mixing with fresh water from the younger alluvial aquifer (DWR 2003b).

Groundwater quality in the Sacramento groundwater basin is generally good and sufficient for agricultural and M&I uses, with TDS levels ranging from 200 to 500 mg/L (Reclamation and DWR 2003). Localized groundwater quality issues occur as a result of natural water quality impairments at the north end of the Sacramento Valley, where marine sedimentary rocks containing brackish to saline water are near the surface (Reclamation and DWR 2003).

Lower Sacramento River and Delta

The groundwater basins underlying the lower Sacramento River and Delta areas include the Sacramento Valley groundwater basin, and North and South San Joaquin Valley groundwater basins.

In the Sacramento groundwater basin, groundwater flows inward from the edges of the basin and south parallel to the Sacramento River. Groundwater extraction in some local areas resulted in groundwater depressions and local groundwater gradients (Reclamation and DWR 2003). Before completion of CVP facilities (1964 through 1971), pumping along the west side of the basin caused groundwater levels to decline. In the Sacramento groundwater basin, a slight decline of 2 to 12 feet was experienced in groundwater levels as a result of the 1976 through 1977 and 1987 through 1994 droughts. This was followed by a recovery to predrought conditions of the early 1970s and 1980s. Generally, groundwater level data show an average seasonal fluctuation ranging from 2 to 15 feet. Groundwater production in the basin increased from 500,000 acre-feet in the 1940s to 2 MAF annually in the mid-1990s.

As mentioned, groundwater quality in the Sacramento groundwater basin is generally good and is sufficient for agricultural and M&I uses, with TDS levels ranging from 200 to 500 mg/L (Reclamation and DWR 2003).

CVP/SWP Service Areas

The groundwater basins underlying the CVP/SWP service areas include the San Joaquin Valley, Santa Clara Valley, Antelope Valley, Fremont Valley, Coastal Plain of Los Angeles, and Coastal Plain of Orange County groundwater basins, and multiple other smaller groundwater basins underlying areas that receive water from the CVP/SWP system.

The San Joaquin Valley groundwater basin is a regional basin and is the largest in California, extending approximately from the Delta to Bakersfield. Areas within the San Joaquin Valley groundwater basin are heavily groundwater-reliant. Groundwater accounts for about 30 percent of the annual supply used for agricultural and urban purposes (Reclamation and DWR 2003). Groundwater production in the north San Joaquin Valley groundwater basin alone increased from 1.5 MAF annually in the 1920s to more than 3.5 MAF annually in 1990 (Reclamation and DWR 2003). In the south San Joaquin Valley groundwater basin, groundwater production for agriculture rose from approximately 3.0 MAF per year in the 1920s to more than 5.0 MAF per year in the 1980s (Reclamation and DWR 2003). Much of the San Joaquin groundwater basin is in overdraft conditions because of extensive groundwater pumping and irrigation, although the extent of overdraft varies widely from region to region.

Groundwater quality throughout the San Joaquin Valley is in general suitable for most urban and agricultural uses. Average TDS concentrations range from 218 to 1,190 mg/L. Areas of high TDS concentration, primarily along the west side of the San Joaquin Valley, are the result of streamflow recharge that originates from marine sediments. High TDS concentrations are also seen in the trough of the San Joaquin Valley because of concentration of salts resulting from evaporation and poor drainage (Reclamation and DWR 2003). Agricultural pesticides and herbicides have been detected in groundwater throughout the region, but primarily along the east side of the San Joaquin Valley, where soil permeability is higher and depth to groundwater is shallower. From 1994 to 2000, 523 public wells out of 689 wells sampled met the State primary maximum contamination levels for drinking water. The remaining wells have constituents that exceed one or more maximum contamination levels (Reclamation and DWR 2003).

6.2 Regulatory Framework

6.2.1 Federal

The following Federal laws, regulations, standards, and plans are discussed as part of the regulatory setting:

- The U.S. Department of the Interior, Fish and Wildlife Service (USFWS) 2008 *Formal Endangered Species Act Consultation on the Proposed Coordinated Operations of the CVP and SWP* (2008 USFWS Biological Opinion (BO)) (USFWS 2008)
- The National Marine Fisheries Service (NMFS) 2009 *BO and Conference Opinion on the Long-Term Operations of the CVP and SWP* (2009 NMFS BO) (NMFS 2009b)
- Central Valley Project Improvement Act (CVPIA) (Reclamation 1999)
- San Joaquin River Restoration Program (SJRRP) Programmatic Environmental Impact Statement/Environmental Impact Report (PEIS/R) (Reclamation and DWR 2012)
- CVP long-term water service contracts
- Trinity River Record of Decision (ROD) (Reclamation 2000)
- Flow objective for navigation (Wilkins Slough)
- Flood management requirements

Regulatory requirements include the 2008 USFWS BO, the 2009 NMFS BO and associated Reasonable and Prudent Alternatives (RPA), and the agreement between the United States and the State for the coordinated operation of the CVP and SWP, otherwise commonly known as the “Coordinated Operations Agreement” (COA).

Ongoing consultation for the 2008 USFWS and 2009 NMFS BOs have resulted in some uncertainty in future CVP and SWP operational constraints. In response to lawsuits challenging the 2008 and 2009 BOs, the District Court for the Eastern District of California (District Court) remanded the BOs to USFWS and NMFS in 2010 and 2011, respectively, and subsequently ordered reconsultation and preparation of new BOs. These legal challenges may result in changes to CVP and SWP operational constraints if the revised USFWS and NMFS BOs contain new or amended RPAs.

Despite this uncertainty, the 2008 and 2009 BOs issued by the fishery agencies contain the most recent estimate of potential changes in water operations that could occur in the near future. Because the RPAs contained in the 2008 and 2009 BOs have the potential to significantly impact SWP/CVP operations and potential benefits of the SLWRI, they have been implemented in this analysis.

National Marine Fisheries Service 2009 Biological Opinion

The 2009 NMFS BO addresses the effects of the continued long-term operation of the CVP and SWP on Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead and their critical habitat, as well as the green sturgeon and its proposed critical habitat and the killer whale (NMFS 2009). The BO includes an RPA that specifies a number of actions, including formation of operation groups, habitat improvements, monitoring requirements and fish passage as well as flow and temperature objectives. Key operational actions in the NMFS RPA that would directly affect project water operations, mainly flow and temperature objectives are listed below. Operations in the RPA that were directly modeled in CalSim II are described in Table 2-2 of the Modeling Appendix.

Shasta-Trinity Division

- Clear Creek flow and temperature objectives
- Reclamation deliverable water forecast procedures
- End-of-year (September 30) Shasta target storages
- Sacramento River temperature objectives between Keswick Dam and Bend Bridge

American River Division

- Lower American River flow objectives
- Lower American River temperature objectives

East Side Division

- Stanislaus River flow objectives
- Stanislaus River temperature objectives

Delta Division

- Delta Cross Channel gate operation
- San Joaquin River Inflow to Export Ratio objectives
- Old and Middle River (OMR) negative or reverse flow objectives

U.S. Fish and Wildlife Service 2008 Biological Opinion

The 2008 USFWS BO addresses the effects of the continued operation of the CVP and SWP on delta smelt and its critical habitat (USFWS 2008). The BO included habitat restoration, formation of the smelt working group, and monitoring requirements as well as RPA actions that would impact project operations. This section discusses the actions in the RPA that would directly affect project water operations, mainly flow and delta salinity conditions. The details on how these were implemented in the modeling and subsequent analysis are included in the Table 2-2 of the Modeling Appendix.

- OMR flow limits of no more than -1500 to -5000 cfs during periods when delta smelt could be subject to entrainment at the pumps.
- X2 location limits during the fall following above normal and wet years.

Central Valley Project Improvement Act

Reclamation's evolving mission was written into law on October 30, 1992, with the passage by Congress, and signing by President George H. W. Bush, of Public Law 102-575, the Reclamation Projects Authorization and Adjustment Act of 1992. Included in the law was Title 34, the CVPIA (Reclamation 1999). The CVPIA amended previous authorizations of the CVP to include fish and wildlife protection, restoration, and mitigation as project purposes having equal priority with irrigation and domestic water supply uses, and fish and wildlife enhancement having equal priority with power generation. Among the changes mandated by the CVPIA are the following:

- Dedicating 800,000 acre-feet annually to fish, wildlife, and habitat restoration
- Authorizing water transfers outside the CVP service area
- Implementing the Anadromous Fish Restoration Program
- Creating a restoration fund financed by water and power users
- Providing for the Shasta Dam temperature control device (TCD)
- Implementing fish passage measures at RBPP

- Planning to increase water supplies for CVP deliveries
- Mandating firm water supplies for Central Valley wildlife refuges
- Meeting Federal trust responsibility to protect fishery resources on the Trinity River

The CVPIA is being implemented on a broad front. The Final Programmatic Environmental Impact Statement (Reclamation 1999) for the CVPIA analyzes projected conditions in 2022, 30 years from the CVPIA's adoption in 1992. The Final Programmatic Environmental Impact Statement was released in October 1999, and the CVPIA ROD was signed on January 9, 2001.

Operations of the CVP reflect provisions of the CVPIA, particularly Sections 3406 (b)(1), (b)(2), and (b)(3). The U.S. Department of the Interior Final Decision on Implementation of Section 3406 (b)(2) of the CVPIA, May 9, 2003 provides the basis for implementing upstream and Delta actions with CVP delivery capability. The Vernalis Adaptive Management Program assumes that San Joaquin River water will be acquired under Section 3406 (b)(3) to support increased Vernalis flows during certain times of the year. Similarly, the Anadromous Fish Restoration Program assumes Sacramento River water will be acquired under Section 3406 (b)(3).

San Joaquin River Restoration Program

The SJRRP was established in 2006 to implement the Stipulation of Settlement in *NRDC, et al., v. Kirk Rodgers, et al.* (Settlement). Federal authorization for implementing the Settlement is provided in the San Joaquin River Restoration Settlement Act, included in Public Law 111-11. Alternatives for implementation of the Settlement and related legislation were evaluated in the SJRRP PEIS/R (Reclamation and DWR 2012).

The Settlement calls for releases of water from Friant Dam to the confluence of the Merced River, referred to as Interim and Restoration flows; a combination of channel-related and structural modifications along the San Joaquin River below Friant Dam; and reintroduction of Chinook salmon. Restoration Flows are specific volumes of water to be released from Friant Dam during different year types, according to Exhibit B of the Settlement. Interim Flows were experimental flows that were implemented from 2009 until Restoration Flows were implemented in 2014. Interim Flows allowed the SJRRP to collect relevant data about flows, temperatures, fish needs, seepage losses, recirculation, recapture, and reuse.

The release of Interim Flows began in October 2009; however, the release of Interim Flows was limited by channel capacity constraints between Friant Dam and the Merced River confluence. The release of Restoration Flows began on January 1, 2014, but is currently restricted due to capacity constraints. Full Restoration Flows are intended to include annual releases from Friant Dam of up to 840,000 acre-feet, depending on year type. In some years, peak releases from Friant Dam could reach as much as 8,000 cfs for several hours, within the constraints of channel capacity. For the SLWRI, existing conditions include Interim Flows and future conditions include full Restoration Flows.

Central Valley Project Long-Term Water Service Contracts

In accordance with CVPIA Section 3404c, Reclamation is renegotiating long-term water service contracts. As many as 113 CVP water service contracts in the Central Valley may be renewed during this process. Reclamation issued a Notice of Intent for long-term contract renewal in October 1998. Environmental documentation was prepared on a regional basis. In February 2005, Reclamation issued decisions (a ROD or Finding of No Significant Impact) for renewing contracts of the Sacramento River, San Luis, and Delta-Mendota Canal divisions, the Sacramento River settlement contracts, and several individual contracts. Preparation of environmental documents for other divisions and contracts is ongoing.

Trinity River Record of Decision

Export of Trinity River water to the Sacramento basin provides increased water supply for the CVP and is a major source of CVP power generation. The amounts and timing of the Trinity exports are determined after consideration is given to forecasted Trinity water supply available and Trinity in-basin needs, including carryover storage. Trinity exports also are a key component of water temperature control operations on the upper Sacramento River.

Based on the December 19, 2000, Trinity River Mainstem ROD (Reclamation 2000), 368,600 to 815,000 acre-feet are allocated annually for Trinity River flows. After several challenges and injunctions, on July 13, 2004, the Ninth Circuit Court upheld the ROD flows for the Trinity River.

Flow Objective for Navigation (Wilkins Slough)

Historical commerce on the Sacramento River resulted in the requirement to maintain minimum flows of 5,000 cfs at Chico Landing to support navigation. Currently, no commercial traffic exists between Sacramento and Chico Landing, and USACE has not dredged this reach to preserve channel depths since 1972. However, long-time water users diverting from the river have set their pump intakes just below this level. Therefore, the CVP is operated to meet the navigation flow requirement of 5,000 cfs to Wilkins Slough under all but the most critical water supply conditions to facilitate pumping.

At flows below 5,000 cfs at Wilkins Slough, diverters have reported increased pump cavitation as well as greater pumping head requirements. Diverters operate for extended periods at flows of 4,000 cfs at Wilkins Slough, but pumping operations are severely affected and some pumps become inoperable at flows lower than 4,000 cfs. Flows may drop as low as 3,500 cfs for short periods while changes are made in Keswick releases to reach target levels at Wilkins Slough.

No criteria have been established that specify when the navigation minimum flow should be relaxed. However, the basis for Reclamation's decision to operate at less than 5,000 cfs is the increased importance of conserving water when water supplies are not sufficient to meet full contractual deliveries and other operational requirements.

Flood Management Requirements

Shasta Dam provides flood protection to the nearby communities of Redding, Anderson, Red Bluff, and Tehama, as well as to agricultural lands, industrial developments, and communities downstream along the Sacramento River. Shasta Dam is operated for an objective release of 100,000 cfs at Bend Bridge in Red Bluff, subject to consideration of the following:

- Releases are not to be increased more than 15,000 cfs or decreased more than 4,000 cfs in any 2-hour period.

- The 2,500-square-mile uncontrolled drainage area between Keswick Dam and Bend Bridge can produce flows well in excess of the design channel capacity of 100,000 cfs. These high-magnitude flows can occur very rapidly, requiring release changes based on official flow forecasts, and are complicated by the 8- to 12-hour travel time between Keswick Dam and Bend Bridge.

- Flow gages on major east side tributaries (Cow, Battle, and Paynes creeks) between Keswick Dam and Red Bluff are helpful in coordinating operations of Shasta Dam and Reservoir with flows from uncontrolled downstream areas. Whiskeytown Dam, located on Clear Creek, provides regulation of Trinity River flows and regulates runoff to the Sacramento River from the Clear Creek drainage area. The most critical flood forecast for the Sacramento River is that of local runoff entering the Sacramento River between Keswick Dam and Bend Bridge. As the Bend Bridge flow is projected to recede, Keswick Dam releases are increased to evacuate water stored in the flood management space in Shasta Reservoir.

The following constraints are considered when making release changes at Keswick Dam:

- The maximum capacity of Shasta Powerplant is about 18,000 cfs, but this varies considerably with head. Maximum powerplant release is required when Shasta Reservoir storage encroaches on the flood management space by 25 percent or less, with actual or forecasted inflows of 40,000 cfs or less.

- The capacity of Keswick Powerplant is about 16,000 cfs, which represents a maximum release rate when no flood management space is being used. The Keswick Dam release must include discharge from

Spring Creek Powerplant, releases from Spring Creek Debris Dam, and local flows into Keswick Reservoir.

- Flows greater than 36,000 cfs begin to cause flood coordination efforts in the local Redding area to close riverfront roads and parks. These coordination efforts require some advance notice to increase Keswick releases above this rate.

All outflows from Shasta Dam flow into and through Keswick Reservoir, located about 5 miles west of Redding. Keswick Reservoir also receives inflow from the drainage area of Whiskeytown Reservoir on Clear Creek. Clear Creek flows are augmented by the interbasin transfer coming from Trinity Reservoir (see Section 6.1.2, "Diversion Facilities").

Flood Management Space Requirements Shasta Reservoir capacity is 4.552 MAF, with a maximum objective release capacity of 79,000 cfs. The end-of-September storage target for Shasta Reservoir is 1.9 MAF, except in the driest 10 percent of water years, to conserve sufficient cold water for meeting temperature criteria for the winter-run Chinook incubation period (summer to early fall). Storage levels are lowest by October to provide sufficient flood protection and capture capacity during the following wet months. The storage target gradually increases from October to full pool in May. Storage is then withdrawn for high water demand (i.e., municipal, agricultural, fishery, and water quality uses) during summer.

A storage space of up to 1.3 MAF below a full pool elevation of 1,067 feet is also kept available for flood management purposes in the reservoir in accordance with the Shasta Dam and Lake Flood Control Diagram (USACE 1977) , as prescribed by USACE (USACE 1977) (see Exhibit B in the *Hydrology, Hydraulics, and Water Management Technical Report*). Under the diagram, flood management storage space increases from zero on October 1 to 1.3 MAF (elevation 1,018.55) on December 1, and is maintained until December 23. From December 23 to June 15, the required flood management space varies according to parameters based on the accumulation of seasonal inflow. This variable space allows for the storage of water for conservation purposes, unless it is required for flood management based on basin wetness parameters and the level of seasonal inflow. Daily flood management operation consists of determining the required flood storage space reservation, and scheduling releases in accordance with flood operations criteria.

Objective Flow The current regulation of Shasta Dam for flood management requires that releases be restricted to quantities that will not cause downstream flows or stages to exceed, insofar as possible, (1) a flow of 79,000 cfs at the tailwater of Keswick Dam and (2) a stage of 39.2 feet for the Sacramento River at the Bend Bridge gaging station near Red Bluff (corresponding roughly to a flow of 100,000 cfs).

Tributary Inflows Shasta Lake collects flow in the upper Sacramento River watershed, but many uncontrolled tributaries enter the Sacramento River downstream from the dam. Stream gages have been added to major uncontrolled tributaries entering downstream from Shasta Lake (Cow, Battle, Cottonwood, and Thomes creeks). To a limited extent, operators of Shasta Dam can adjust releases containing these uncontrolled flows to try to reduce downstream peak flows. Trinity Lake, Lewiston and Whiskeytown reservoirs can also adjust releases to some extent. Accordingly, the influence of Shasta Dam and Reservoir operation on reducing peak flood flows diminishes downstream on the Sacramento River.

6.2.2 State

The following State laws, regulations, standards, and plans are discussed as part of the regulatory setting:

- State Water Resources Control Board (State Water Board) Orders 90-05 and 91-01
- 1960 CDFW-Reclamation Memorandum of Agreement (CDFG and Reclamation 1960)
- Water Quality Control Plan (WQCP) for the San Francisco Bay/San Joaquin Delta Estuary (State Water Board 1995)
- State Water Board Revised Water Right Decision 1641 (RD-1641) (State Water Board 2000)
- COA (Reclamation and DWR 1986)
- Groundwater regulations

State Water Resources Control Board Orders 90-05 and 91-1

In 1990 and 1991, the State Water Board issued Water Right Orders 90-05 and 91-01 modifying Reclamation's water rights for the Sacramento River. The orders included a narrative water temperature objective for the Sacramento River, and stated that Reclamation shall operate Keswick and Shasta dams and Spring Creek Powerplant to meet a daily average water temperature of 56°F at RBPP in the Sacramento River during periods when higher temperatures would be harmful to fisheries.

Under the orders, the water temperature compliance point may be modified when the objective cannot be met at RBPP. The Sacramento River Temperature Task Group (SRTTG), a multiagency group, develops temperature operational plans for the Shasta and Trinity divisions of the CVP pursuant to State Water Board Water Rights Orders 90-5 and 91-1. These temperature plans consider the impacts to winter-run Chinook salmon and other races of Chinook salmon from project operations. Previous plans have included releases of water from the low-level outlets at Shasta Dam and Trinity Dam, operation of the TCD, warm-water releases, and manipulating the timing of Trinity River diversions through Spring Creek Powerplant. Warm-water releases from the upper level outlets have been made to conserve cold water in Shasta Lake for temperature control in the late summer and to induce winter-run Chinook salmon to spawn as far upstream as possible. The SRTTG typically first meets in the spring once the cold-water availability in Shasta Lake is known. In almost all years since installation of the TCD on Shasta Dam in 1997, those plans have included modifying the compliance point near the RBPP to make the best use of the cold-water resources based on the location of spawning Chinook salmon (NMFS 2009).

The water right orders also recommended construction of a TCD to improve management of the limited cold-water resources. Two temperature control curtains were installed at both the Lewiston Reservoir and the Whiskeytown Reservoir to reduce temperature of water released from the Trinity Dam (Vermeyen 1995). Reclamation constructed the TCD on Shasta Dam in 1997. This device releases cool water from Shasta Lake through low-level river outlets that bypass the powerplant. These devices provide flexibility to Shasta Dam operations and allows downstream temperature goals to be consistently achieved (Reclamation 2004).

Reclamation operates the Shasta, Sacramento River, and Trinity River divisions of the CVP to meet, to the extent possible, the provisions of State Water Board Order 90-05 and 91-01 and the 2009 NMFS BO.

1960 California Department of Fish and Wildlife-Reclamation Memorandum of Agreement

An April 5, 1960, Memorandum of Agreement between CDFW and Reclamation (CDFW and Reclamation 1960) originally established flow objectives in the Sacramento River for the protection and preservation of fish and wildlife resources. The agreement provided for minimum releases into the natural channel of the Sacramento River at Keswick Dam for normal and critical years. Since October 1981, Keswick Dam has been operated based on a minimum release of 3,250 cfs for normal years from September 1 through the end of February, in accordance with an agreement between CDFW and Reclamation. This release schedule was included in Order 90-05, which maintains a minimum release of 3,250 cfs at Keswick Dam and RBPP from September through the end of February in all water years, except critical years.

Water Quality Control Plan for the San Francisco Bay/San Joaquin Delta Estuary

The 1995 San Francisco Bay/Sacramento-San Joaquin Delta (Bay-Delta) WQCP (State Water Board 1995) established water quality control objectives for the protection of beneficial uses in the Delta. The 1995 WQCP identified (1) beneficial uses of the Delta to be protected, (2) water quality objectives for the reasonable protection of beneficial uses, and (3) a program of implementation for achieving the water quality objectives. Because these new beneficial objectives and water quality standards were more protective than those of the previous State Water Board Water Right Decision 1485, the new objectives were adopted in 1995 through a water right order for operation of the CVP and SWP. Key features of the 1995 WQCP include estuarine habitat objectives for Suisun Bay and the western Delta (consisting of salinity measurements at several locations), export/inflow (E/I) ratios intended to reduce entrainment of fish at the export pumps, Delta Cross Channel gate closures, and San Joaquin River electrical conductivity (EC) and flow standards. The State Water Board adopted a new Bay-Delta WQCP on December 13, 2006. However, this new WQCP made only minor changes to the 1995 WQCP.

State Water Resources Control Board Revised Water Right Decision 1641

The 1995 Bay-Delta WQCP contains current water quality objectives. State Water Board RD-1641 (State Water Board 2000) and Water Right Order 2001-05 contain the current water right requirements to implement the 1995 WQCP. RD-1641 incorporates water right settlement agreements between Reclamation and DWR and certain water users in the Delta and upstream watersheds regarding contributions of flows to meet water quality objectives. However, the State Water Board imposed terms and conditions on water rights held by Reclamation and DWR that require these two agencies, in some circumstances, to meet many of the water quality objectives established in the 1995 WQCP. RD-1641 also authorizes the CVP and SWP to use joint points of diversion (JPOD) in the south Delta, and recognizes the CALFED Bay-Delta Program (CALFED) Operations Coordination Group process for operational flexibility in applying or relaxing certain protective standards.

Delta Outflow Requirement Delta outflow, inflow that is not exported or diverted, is the primary factor controlling water quality in the Delta. When Delta outflow is low, seawater is able to intrude further into the Delta, impacting water quality at drinking water intakes. RD-1641 specifies minimum monthly Delta outflow objectives to maintain a reasonable range of salinity in the estuarine aquatic habitat based on the Net Delta Outflow Index (NDOI). The NDOI is a measure of the freshwater outflow and is determined from a water balance that considers river inflows, precipitation, agricultural consumptive demand, and project exports. The NDOI does not take into account the semidiurnal and spring-neap tidal cycles.

The monthly minimum values of the NDOI specified in RD-1641 depend on the water year type. Minimum flows are specified for the months of January and July to December. The outflow objectives from February to June are determined based on the X2[2] objective.

Delta Salinity Objectives Salinity standards for the Delta are stated in terms of EC (for protection of agricultural and fish and wildlife beneficial uses), and

[2] X2 is the most downstream location of either the maximum daily average or the 14-day running average of 2.64 millimhos per centimeter (mmhos/cm) isohaline, as measured in river kilometers from the Golden Gate Bridge.

chloride (for protection of M&I uses). Compliance values vary with water year and month. The salinity objectives at Emmaton on the Sacramento River and at Jersey Point on the San Joaquin River often control Delta outflow requirements during the irrigation season from April through August, requiring additional releases from upstream CVP and SWP reservoirs.

X2 Objective The location of X2, the 2 parts per thousand salinity unit isohaline at 1 meter above the bottom of the Sacramento River channel, is used as a surrogate measure of ecosystem health in the Delta. The X2 objective requires specific daily surface EC criteria to be met for a certain numbers of days each month, from February through June. Compliance can also be achieved by meeting a 14-day running average salinity or 3-day average outflow equivalent. These requirements were designed to provide improved shallow water habitat for fish species in the spring. Because of the relationship between seawater intrusion and interior Delta water quality, the X2 objective also improves water quality at Delta drinking water intakes.

Maximum Export/Inflow Ratio RD-1641 includes a maximum E/I standard to limit the fraction of Delta inflows that are exported. This requirement was developed to protect fish species and to reduce entrainment losses. Delta exports are defined as the combined pumping of water at Banks and Jones pumping plants. Delta inflows are the gaged or estimated river inflows. The maximum E/I ratio is 0.35 for February through June and 0.65 for the remainder of the year. If the January eight-river runoff index is less than 1.0 MAF, the February E/I ratio is increased to 0.45. The CVP and SWP have agreed to share the allowable exports equally if the E/I ratio is limiting exports.

Joint Point of Diversion The JPOD refers to the CVP and SWP use of each other's pumping facilities in the south Delta to export water from the Delta. The CVP and SWP have historically coordinated use of Delta export pumping facilities to assist with deliveries and to aid each other during times of facility failures. In 1978, by agreement with DWR, and with authorization from the State Water Board, the CVP began using the SWP Banks Pumping Plant for replacement pumping (195,000 acre-feet per year) for pumping capacity lost at Jones Pumping Plant because of striped bass pumping restrictions in State Water Board Water Right Decision 1485. In 1986, Reclamation and DWR formally agreed that "either party may make use of its facilities available to the other party for pumping and conveyance of water by written agreement" and that the SWP would pump CVP water to make up for striped bass protection measures (Reclamation and DWR 1986).

Reclamation filed a number of temporary petitions with the State Water Board to use Banks Pumping Plant for purposes other than replacement pumping and CVP deliveries that contractually relied on SWP conveyance. Such uses included deliveries to Cross Valley Contractors, the Musco Olive Company, and the San Joaquin National Cemetery. In RD-1641, the State Water Board conditionally approved the use of the JPOD in three separate stages:

- Stage 1 is the use of the JPOD to serve Cross Valley Canal contractors, the Musco Olive Company and the San Joaquin National Cemetery; to support a recirculation study; and to recover export reductions made to benefit fish. Authorization for Stage 1 JPOD pumping to recover export reductions prohibits the CVP and SWP from annually exporting more water than each would have exported without the use of each other's pumping facilities. Stage 1 pumping is subject to State Water Board approval of a water level response plan, and a water quality response plan.

- Stage 2 is the use of the JPOD for any purpose authorized in the water rights permits up to the limitations contained in the USACE permit. In addition to the Stage 1 requirements, Stage 2 pumping is subject to State Water Board approval of an operations plan to protect aquatic resources and other legal users of water.

- Stage 3 is the use of the JPOD for any purpose authorized under the water right permits up to the physical capacity of the export pumps. Stage 3 is subject to the operation of barriers or other means to protect water levels in the south Delta, a State Water Board-approved operations plan that adequately protects aquatic resources and other legal users of water, and certification of a project-level EIR by DWR for the South Delta Improvements Program.

The State Water Board has had a policy that all water transfers must meet similar criteria and conditions, as set forth for the JPOD, and the State Water Board has mandated a "response plan" evaluation process for real-time incremental export operations to determine the effects of water transfers and JPOD operations. The State Water Board approval of the 2006 and 2007 Accord Pilot Programs included the provision that rediversion of transfer water at Banks and Jones pumping plants must be in compliance with the various plans under RD-1641 that are prerequisites for the use of the JPOD by Reclamation and DWR.

Reclamation and DWR have produced the following response plans:

- Water Level Response Plan, to address incremental effects of additional export, at the time of the export, to water levels in the south Delta environment (Reclamation and DWR 2004a)

- Water Quality Response Plan, to address incremental effects of additional export, at the time of the export, to water quality in the Delta, and south Delta specifically (Reclamation and DWR 2004b)

- Operations Plan, to protect fish and wildlife, and other legal uses of water

Vernalis Adaptive Management Plan The Vernalis Adaptive Management Plan (VAMP) was a 12-year experimental management program proposed under the 1998 San Joaquin River Agreement (SJRA), which was adopted by the State Water Resources Control Board (State Water Board) in Water Right Decision 1641 (December 1999). Although VAMP expired in 2011, VAMP requirements are included in SLWRI modeling to represent interim actions and future State Water Board objectives for San Joaquin River flows at Vernalis.

VAMP was initiated to protect juvenile Chinook salmon emigrating through the San Joaquin River and Delta, and to evaluate how Chinook salmon survival rates change in response to alterations in San Joaquin River flows and exports at CVP and SWP facilities in the south Delta when the Head of Old River Barrier is installed. A water acquisition program for in-stream flows and a monitoring program for VAMP were implemented through the SJRA, which was adopted in 2000 and twice extended, finally expiring in December 2011. Signatories to the SJRA included Reclamation, DWR, CDFW, USFWS, San Joaquin River Group Authority and member agencies, Exchange Contractors, and select CVP and SWP Contractors, San Francisco Public Utilities Commission, and several environmental interest groups.

VAMP provided guidance for flows in the lower San Joaquin River during a 31-day pulse-flow period during April and May. The predicted April 15 San Joaquin River flows at Vernalis were increased by 1 to 2 predefined “steps,” ranging from 1,200 cfs to 1,300 cfs between each step. If the average of water-year conditions for the current year and the previous year was a below-normal, dry, or critical condition, then the flows would only be increased to the next step. However, if the average of water-year conditions for the current year and the previous year was a wet, above-normal, or average (i.e., between above normal and below normal) condition, then the flows would be increased by two steps. During a multiple year drought, when the current and previous two water years were comprised of either (1) three critical years or (2) two critical years and one dry year, there would be no required flow increases under VAMP. VAMP flow requirements typically were met either through additional releases or through reductions in demands from the Merced Irrigation District, Oakdale Irrigation District, Mendota Pool Exchange Contractors, Modesto Irrigation District, and Turlock Irrigation District.

The expiration of VAMP in 2011 introduced uncertainty regarding responsibility for meeting San Joaquin River flow standards set forth in the 1995 Bay Delta Plan until new San Joaquin River flow standards are identified. In 2012 and 2013, Reclamation implemented a “single-step” VAMP, in which flows were increased by only one step in all water year types. It is anticipated that future State Water Board objectives will be as protective as the original VAMP requirements and will remain in place through 2030.

Coordinated Operations Agreement

The COA defines how Reclamation and DWR share their joint responsibility to meet Delta water quality standards and the water demands of senior water right holders, and how the two agencies share surplus flows (Reclamation and DWR 1986). The COA defines the Delta as being in either "balanced water conditions" or "excess water conditions." Balanced water conditions are periods when Delta inflows are just sufficient to meet water user demands within the Delta, outflow requirements for water quality and flow standards, and export demands. Under excess water conditions, Delta outflow exceeds the flow required to meet the water quality and flow standards. Typically, the Delta is in balanced water conditions from June to November, and in excess water conditions from December through May. However, depending on the volume and timing of winter runoff, excess or balanced water conditions may extend throughout the year.

With the goal of using coordinated management of surplus flows in the Delta to improve Delta export and conveyance capability, the COA received Congressional approval in 1986, and became Public Law 99-546. The COA, as modified by interim agreements, coordinates operations between the CVP and SWP, and provides for the equitable sharing of surplus water supply. The COA requires that the CVP and SWP operate in conjunction to meet State water quality objectives in the Bay-Delta estuary, except as specified. Under this agreement, the CVP and SWP can each contract from the other for the purchase of surplus water supplies, potentially increasing the efficiency of water operations.

Since 1986, the COA principles have been modified to reflect changes in regulatory standards, facilities, and operating conditions. At its inception, the COA water quality standards were those of the 1978 WQCP; these were subsequently modified in the 1991 WQCP. The adoption of the 1995 WQCP by the State Water Board superseded those requirements. The Environmental Water Account was established by CALFED in 2000 to protect the fish of the Bay-Delta estuary via changes in the operations of the CVP and SWP, without incurring uncompensated cost to the projects' water users. Evolution of the Clean Water Act over time has also impacted implementation of the COA.

Groundwater Regulations

Groundwater use is subject to limited statewide regulation; however, all water use in California is subject to constitutional provisions that prohibit waste and unreasonable use of water (State Water Board 1999). In general, groundwater is subject to a number of provisions in the Water Code. Assembly Bill 3030, Water Code Section 10750, commonly referred to as the Groundwater Management Act, permits local agencies to develop groundwater management plans (Reclamation and DWR 2003).

Other groundwater regulation is related primarily to water quality issues, which are addressed by several different State agencies, including the State Water

Board and nine Regional Water Quality Control Boards, the California Department of Toxic Substances Control, Department of Pesticide Regulation, and Department of Health Services.

The Supplemental Report of the 1999 Budget Act required the State Water Board to develop a comprehensive ambient groundwater monitoring plan. To meet this mandate, the State Water Board created the Groundwater Ambient Monitoring and Assessment (GAMA) Program. The primary objective of the GAMA Program is to assess water quality and relative susceptibility of groundwater resources. The GAMA Program has two sampling components: the California Aquifer Susceptibility Assessment for addressing public drinking water wells, and the Voluntary Domestic Well Assessment Project for addressing private drinking water wells.

The GAMA Program is being directed by the State Water Board Division of Water Quality, Land Disposal Section, Groundwater Special Studies Unit. The Voluntary Domestic Well Assessment Project samples domestic wells for various constituents commonly found in domestic well water, and provides that information to domestic well owners. In addition, the Voluntary Domestic Well Assessment Project includes a public education component to aid the public in understanding water quality data and water quality issues affecting domestic water wells. The Voluntary Domestic Well Assessment Project focuses on specific areas, as resources permit. The focus areas are chosen based on existing knowledge of water quality and land use, in coordination with local environmental agencies. The State Water Board incurs the costs of sampling and analysis, and results are provided to domestic well owners as quickly as possible.

6.2.3 Regional and Local

The following local laws, regulations, standards, and plans are discussed as part of the regulatory setting:

- Local surface water regulations (i.e., water supply master plans, general plans, habitat and conservation plans, land use ordinances)
- Local groundwater regulations (i.e., management plans, county ordinances)

Local Surface Water Regulations

Local surface water regulations include goals, objectives, and policies pertaining to the primary and extended study areas, including the following:

- Local water supply master plans
- County general plans
- City general plans

- Local habitat and conservation plans (e.g., Natomas Basin Habitat Conservation Plan)
- Local land-use ordinances

Local Groundwater Regulations

Local regulatory setting documents on groundwater resources in the study areas include local groundwater management plans and county ordinances. Table 6-1 lists current groundwater management plans and county ordinances that apply to agencies in the Redding Area and Sacramento Valley groundwater basins. Groundwater management plans and county ordinances in the San Joaquin Valley groundwater basins are presented in Table 6-2. These documents typically involve provisions to limit or prevent groundwater overdraft, protect groundwater quality, and regulate transfers.

Table 6-1. Groundwater Management Plans and County Ordinances for Redding Area and Sacramento Valley Groundwater Basins

Groundwater Basin	Agency	Plan Name	Year
Redding Area: Subbasins include-- Bowman, Rosewood, Anderson, Enterprise, Millville, and South Battle Creek	Shasta County Water Agency for Redding Area Water Council	Coordinated GWMP for the Redding Groundwater Basin	2007
	Anderson-Cottonwood ID	ACID GWMP	2006
	Shasta County	Shasta County Ordinance No. SCC-98-1	1998
	Tehama County	Tehama County Urgency Ordinance No. 1617	1997
Sacramento Valley: Subbasins include-- Red Bluff, Corning, Colusa, Bend, Antelope, Dye Creek, Los Molinos, Vina, West Butte, East Butte, North Yuba, South Yuba, Sutter, North American, South American, Solano, Yolo, Capay Valley	Tehama County Flood Control and Water Conservation District	Coordinated AB 3030 GWMP-Draft	2012
	Sutter County	Sutter County Groundwater Management Plan	2012
	City of Woodland	Groundwater Management Plan	2011
	City of Vacaville	AB 3030 GWMP	2011
	Sacramento Groundwater Authority	Groundwater Management Plan	2008
	Reclamation District 2035	GWMP	2008
	Dunnigan WD	Dunnigan WD GWMP	2007
	Diablo Water District	GWMP for AB 3030	2007
	Yolo County Flood Control and Water Conservation District	GWMP	2006
	Sacramento County Water Agency	Central Sacramento County GWMP	2006
	City of Davis/University of California, Davis	GWMP	2006
	Reclamation District No. 787	GWMP	2005
	Yuba County Water Agency	Yuba County Water Agency GWMP	2010
	Reclamation District 2068	GWMP	2005

Table 6-1. Groundwater Management Plans and County Ordinances for Redding Area and Sacramento Valley Groundwater Basins (contd.)

Groundwater Basin	Agency	Plan Name	Year
Sacramento Valley: Subbasins include--Red Bluff, Corning, Colusa, Bend, Antelope, Dye Creek, Los Molinos, Vina, West Butte, East Butte, North Yuba, South Yuba, Sutter, North American, South American, Solano, Yolo, Capay Valley (contd.)	Feather Water District	GWMP	2005
	Butte County	Butte County Groundwater Management Plan	2004
	Sacramento County Water Agency	GWMP	2004
	City of Lincoln	City of Lincoln GWMP	2003
	Placer County Water Agency	West Placer GWMP	2003
	Natomas Central Mutual Water Company	GWMP	2002
	Maine Prairie WD	Maine Prairie Water District GWMP	1997
	Reclamation District 1500	GWMP	1997
	Butte WD	Butte WD GWMP	1996
	El Camino ID	El Camino ID GWMP	1995
	Glenn-Colusa ID	Glenn-Colusa ID GWMP AB 3030	1995
	Western Canal WD	GWMP	1995
	Biggs-West Gridley WD	Biggs-West Gridley WD GWMP	1995
	Richvale ID	Richvale ID GWMP	1995
	Thermalito ID	Thermalito ID GWMP	1995
	Sutter Extension Water District	Sutter Extension GWMP	1995
	Sacramento Metropolitan Water Authority	GWMP Initial Phase	1994
	Glenn County	Glenn County Ordinance No. 1115	2000
	Colusa County	Colusa County Ordinance No. 615	2009
	Yolo County	Yolo County Export Ordinance No. 615	1970
	Butte County	Chapter 33 of the Butte County Code	2000
	Butte County	Well Spacing Ordinance	1999/2014
	Glenn County	Ordinance No. 1115 and BMOs	2000
	The Water Forum	Water Forum Agreement	2000

Key:
AB = Assembly Bill
ACID = Anderson-Cottonwood Irrigation District
BMO = Basin Management Objective
GWMP = Groundwater Management Plan
ID = Irrigation District
No. = Number
SCC = Shasta County Code
WD = Water District

Table 6-2. Groundwater Management Plans and County Ordinances for San Joaquin Valley Groundwater Basins

Groundwater Basin	Agency	Plan Name	Year
San Joaquin Valley: Subbasins include--Eastern San Joaquin, Modesto, Turlock, Merced, Chowchilla, Madera, Delta-Mendota, Tracy, Cosumnes	Turlock GW Basin Association	Turlock GW basin GWMP	2008
	San Joaquin River Exchange Contractors Water Authority	AB 3030-GWMP	2008
	Merced Area Groundwater Pool Interests and Stevinson WD	Merced GW basin GWMP	2008
	San Luis and Delta Mendota Water Authority-North	GWMP for the Northern Agencies in the Delta-Mendota Canal Service Area and a Portion of San Joaquin County	2007
	City of Tracy	Tracy Sub-basin Regional Groundwater Management Plan	2007
	City of Tracy	Tracy Regional GWMP	2007
	Modesto Subbasin	Modesto Subbasin Integrated Regional GWMP	2005
	Eastern San Joaquin Groundwater Banking Authority	Eastern San Joaquin groundwater basin GWMP	2004
	Root Creek WD	GWMP for Root Creek Water District	2003
	Madera County	AB 3030 GWMP	2002
	Southeast Sacramento County Agricultural Water Authority GWMP	Southeast Sacramento County Agricultural Water Authority GWMP	2002
	Calaveras County WD	Camanche Valley Springs AB 3030 GWMP	2001
	Madera ID	AB 3030 GWMP	1999
	Gravelly Ford WD	GWMP for Gravelly Ford ID	1998
	Turlock ID	GWMP	1997
	Chowchilla WD-Red Top Resource Conservation District Joint Powers Authority	GWMP	1997
	Madera WD	GWMP for Madera WD	1997
	Merced ID	Merced ID GWMP	1996
	San Luis and Delta Mendota Water Authority-Southern	GWMP for the Southern Agencies in the Delta-Mendota Canal Service Area	1996
	North San Joaquin WCD	GWMP	1996
	Modesto ID	GWMP for the Modesto ID	1996
	Aliso Water District	GWMP	1996
	Oakdale ID	Oakdale Irrigation District GWMP	1995
	South San Joaquin ID	South San Joaquin Irrigation District GWMP	1995
	Stockton East Water District	Stockton East Water District GWMP	1995
	El Nido ID	El Nido ID GWMP	1995
	Eastside WD	Eastside Water District GWMP	1994
	Merced County	Wellhead Protection Program	1997
	Delano-Earlimart ID	GWMP	2007

Table 6-2. Groundwater Management Plans and County Ordinances for San Joaquin Valley Groundwater Basins (contd.)

Groundwater Basin	Agency	Plan Name	Year
San Joaquin Valley: Subbasins include-- Kings, Westside, Pleasant Valley, Kaweah, Tulare Lake, Tule, Kern County	Kaweah Delta Water Conservation District	Kaweah Delta Water Conservation District GWMP	2006
	Deer Creek and Tule River Authority	Deer Creek and Tule River Authority GWMP	2006
	10 agencies in the Fresno Area	Fresno Area Regional GWMP	2006
	Riverdale ID	GWMP for Riverdale Irrigation District	2005
	Kings River Conservation District	Lower Kings Basin GWMP	2005
	Alta ID	GWMP	2004
	Kings County WD	Kings County Water District GWMP	2004
	Pleasant Valley WD	GWMP	2004
	Semitropic Water Storage District	GWMP	2004
	Arvin-Edison Water Storage District	Arvin-Edison Water Storage District GWMP	2003
	James ID	GWMP for James Irrigation District	2001
	County of Fresno	County of Fresno GWMP	1997
	Orange Cove ID	GWMP	1997
	West Kern WD	West Kern WD GWMP	1997
	Fresno ID	GWMP	1996
	Tulare Lake Reclamation District No. 761	GWMP within the Westside Groundwater Basin	1996
	Westlands WD	GWMP	1996
	Kern Delta WD	Kern Delta Water District GWMP	1996
	Consolidated ID	GWMP	1995
	Kings River Conservation District Area "A"	GWMP for the Kings River Conservation District Area "A"	1995
	Kings River Conservation District Area "B"	GWMP for the Kings River Conservation District Area "B"	1995
	Kings River Conservation District Area "C"	GWMP for the Kings River Conservation District Area "C"	1995
	Lower Tule River ID	Deer Creek and Tule River Authority GWMP	1995
	Rosamond Community Services District	GWMP	1995
	Tulare Lake Bed	Tulare Lake Bed Coordinated GWMP	1994
	North Kern Water Storage District	North Kern Water Storage District GWM Program	1993
	Shafter-Wasco ID	GWM Program	1993
	Fox Canyon Groundwater Management Authority	Groundwater Management Plan for the Fox Canyon Groundwater Management Agency	1985

Key:
AB =Assembly Bill
GW = Groundwater
GWM = Groundwater Management
GWMP = Groundwater Management Plan
ID = Irrigation District
WCD = Water Conservation District
WD = Water District

6.3 Environmental Consequences and Mitigation Measures

The purpose of this section is to provide information about the environmental consequences of the SLWRI study alternatives on hydraulics and hydrology, including water management, and potential impacts on existing facilities. This section describes the methods and assumptions, criteria for determining significant impacts, and impacts and mitigation measures associated with the H&H effects of each of the SWLRI alternatives. Implementation of the action alternatives considered in the study would affect the H&H of the Sacramento River, Feather River, American River, and the CVP/SWP systems. Impacts on the H&H of the CVP/SWP systems would translate to potential impacts on related surface and groundwater supplies available for CVP/SWP water users.

6.3.1 Methods and Assumptions

A suite of modeling tools was used to evaluate the potential impacts of the No-Action Alternative and various SLWRI action alternatives on the H&H of the project, and to quantify potential benefits. The SLWRI 2012 Version CalSim-II model, developed for the SLWRI, was used to simulate CVP and SWP operations, determining the surface water flows, storages, and deliveries associated with each alternative. CalSim-II is a specific application of the Water Resources Integrated Modeling System (WRIMS) to simulate CVP and SWP water operations. A detailed description of the SLWRI 2012Version CalSim-II model, including modeling assumptions, is included in Chapter 2 of the Modeling Appendix. Delta Simulation Model 2 (DSM2), Version 8.0.6, was used to simulate Delta hydrodynamics and Delta water quality, providing the data used to discuss the water-level-related impacts of each alternative. A detailed description of DSM2 and the assumptions used in the SLWRI analysis are included in Chapter 7 of the Modeling Appendix. Analysis and modeling results are summarized below; more detailed results of the CalSim-II output can be found in Attachment 1 of the Modeling Appendix. Attachment 16 of the Modeling Appendix contains detailed results of the DSM2 modeling.

CalSim-II

CalSim-II is the application of the WRIMS software to the CVP/SWP. This application was jointly developed by Reclamation and DWR for comparative planning studies relating to CVP/SWP operations. The primary purpose of CalSim-II is to evaluate the water supply reliability of the CVP and SWP at current and/or future levels of development (e.g., 2005, 2030), with and without various assumed future facilities, and with different modes of facility operations. Geographically, the model covers the drainage basin of the Delta, and CVP/SWP exports to the San Francisco Bay Area, San Joaquin Valley, Central Coast, and Southern California.

CalSim-II simulates system operations for an 82-year period using a monthly time step. The model assumes that facilities, land use, water supply contracts, and regulatory requirements are constant over this period, representing a fixed level of development (e.g., 2005, 2030). The historical flow record of October

1921 to September 2003, adjusted for the influences of land use changes and upstream flow regulation, is used to represent the possible range of water supply conditions. Major Central Valley rivers, reservoirs, and CVP/SWP facilities are represented by a network of arcs and nodes. CalSim-II uses a mass balance approach to route water through this network. Simulated flows are mean flows for the month; reservoir storage volumes correspond to end-of-month storage.

CalSim-II models a complex and extensive set of regulatory standards and operations criteria. Descriptions of both are contained in Chapter 2 of the Modeling Appendix. The hydrologic analysis conducted for this EIS used SLWRI 2012 Version CalSim-II models, which are the best available hydrological modeling tools, to approximate system-wide changes in storage, flow, salinity, and reservoir system reoperation associated with the SLWRI alternatives. Although CalSim-II is the best available tool for simulating system-wide operations, the model also contains simplifying assumptions in its representation of the real system. CalSim-II's planning capability is limited and cannot be readily applied to analyzing flood flows and hourly, daily, or weekly time steps for hydrologic conditions. The model, however, is useful for comparing the relative effects of alternative facilities and operations within the CVP/SWP system.

A general external review of the methodology, software, and applications of CalSim-II was conducted in 2003 (Close et al. 2003). An external review of the San Joaquin River Valley CalSim-II model also was conducted (Ford et al. 2006). Several limitations of the CalSim-II models were identified in these external reviews. The main limitations of the CalSim-II models are as follows:

- Model uses a monthly time step
- Accuracy of the inflow hydrology is uncertain
- Model lacks a fully explicit groundwater representation

In addition, Reclamation, DWR, and external reviewers have identified the need for a comprehensive error and uncertainty analysis for various aspects of the CalSim-II model. DWR has issued the CalSim-II Model Sensitivity Analysis Study (DWR 2005) and Reclamation has completed a similar sensitivity and uncertainty analysis for the San Joaquin River basin (Reclamation and DWR 2006a). This information will improve understanding of model results.

Despite these limitations, monthly CalSim-II model results remain useful for comparative purposes. It is important to differentiate between "absolute" or "predictive" modeling applications and "comparative" applications. In "absolute" applications, the model is run once to predict a future outcome; errors or assumptions in formulation, system representation, data, operational criteria, etc., all contribute to total error or uncertainty in model results. In "comparative" applications, the model is run twice, once to represent a base condition (no-action) and a second time with a specific change (action) to assess the change in the outcome because of the input change. In the comparative mode (the mode used for this EIS), the difference between the two simulations is of principal importance. Most potential errors or uncertainties affecting the "no-action" simulation also affect the "action" simulation in a similar manner; as a result, the effect of errors and uncertainties on the difference between the simulations is reduced. However, not all limitations are fully eliminated by the comparative analysis approach; small differences between the alternatives and the bases of comparison are not considered to be indicative of an effect of the alternative.

DSM2

DSM2 is a branched 1-dimensional model used to simulate hydrodynamics, water quality, and particle tracking in a network of riverine or estuarine channels. The hydrodynamic module can simulate channel stage, flow, and water velocity. The water quality module can simulate the movement of both conservative and nonconservative constituents. DWR uses the model to perform operational and planning studies of the Delta.

DSM2 analysis is typically performed for the period 1922 to 2003. In model simulations, EC is typically used as a surrogate for salinity. Results from CalSim-II are used to define Delta boundary inflows. CalSim-II-derived boundary inflows include the Sacramento River flow at Hood, the San Joaquin River flow at Vernalis, inflow from the Yolo Bypass, and inflow from the eastside streams. In addition, Net Delta Outflow from CalSim-II is used to calculate the salinity boundary at Martinez.

Details of the model, including source codes and model performance, are available online at the DWR Bay-Delta Office's Modeling Support Branch Web site. Documentation on model development is discussed in annual reports to the State Water Board, such as Methodology for Flow and Salinity Estimates in the Sacramento-San Joaquin Delta and Suisun Marsh, prepared by the Delta Modeling Section of DWR (DWR 2009).

6.3.2 Criteria for Determining Significance of Effects

An environmental document prepared to comply with NEPA must consider the context and intensity of the environmental effects that would be caused by, or result from, the proposed action. Under NEPA, the significance of an effect is used solely to determine whether an EIS must be prepared. An environmental document prepared to comply with CEQA must identify the potentially significant environmental effects of a proposed project. A significant effect on the environment means a substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by the project (State CEQA Guidelines, Section 15382). CEQA also requires that the environmental document propose feasible measures to avoid or substantially reduce significant environmental effects (State CEQA Guidelines, Section 15126.4(a)).

The significance criteria were developed based on the guidance provided by the State CEQA Guidelines, and consider the context and intensity of the environmental effects as required under NEPA. Impacts of an alternative on H&H would be significant if project implementation would cause the results in the second column of Table 6-3 to occur. Simulated stream flow and reservoir storage data, generated as part of the H&H impact assessment, were used in the impact assessments for groundwater, hydropower, flood control, water quality, fisheries, terrestrial biology, recreation, and cultural resources. Accordingly, a detailed description of changes in flow and storage expected to result from each of the SLWRI alternatives is included, in addition to the impact analysis.

Significance statements are relative to both existing conditions (2005) and future conditions (2030) unless stated otherwise.

Table 6-3. Impact Indicators and Significance Criteria for Water Management

Impact Indicator	Significance Criterion
Flood Management	Increase frequency or severity of damaging flood flows, as indicated by the following: • Increase frequency of daily flows above 100,000 cfs on the Sacramento River below Bend Bridge • Place housing or other structures within a 100-year flood hazard area as mapped on a Federal flood hazard boundary or Flood Insurance Rate Map or other flood hazard delineation map • Place within a 100-year flood hazard area structures that would impede or redirect flood flows
Water Supply Reliability	Reduce water supply reliability to the following CVP/SWP contractors: • North-of-Delta CVP Water Service Contractors or Refuges • South-of-Delta CVP Water Service Contractors or Refuges • SWP Table A Contractors
Water Levels in the South Delta[1]	Reduce water surface elevation, relative to the basis of comparison, with sufficient frequency and magnitude to adversely affect south Delta water users' abilities to divert water during the irrigation season.
X2 Location	Increase in X2 that adversely affects CCWD's ability to fill Los Vaqueros Reservoir: • Movement of X2 location to west of Chipps Island from February through May • Movement of X2 location to west of Collinsville during December, January, and June
Delta Excess Water Conditions	Reduction in the duration of Delta excess conditions during the November-to-June period that adversely affects CCWD's ability to fill Los Vaqueros Reservoir.
Groundwater Resources	A change in groundwater level or quality that would adversely affect users, as indicated by the following: • A change in groundwater level resulting in long-term overdraft conditions for the groundwater basins • A change groundwater quality resulting in substantially adverse effects to designated beneficial uses of groundwater.

Note:
[1] Changes in south Delta water levels are estimated using the DSM2 Model.

Key
CCWD = Contra Costa Water District
cfs = cubic feet per second
CVP = Central Valley Project
Delta = Sacramento-San Joaquín Delta
SWP = State Water Project

Flood Management

To prevent an increase in flood damages in the study area, the SLWRI must not cause a significant increase in the frequency or magnitude of flood flows on the Sacramento River. The current regulation of Shasta Dam for flood control requires that releases be restricted to quantities that will not cause downstream flows or stages to exceed, insofar as possible, (1) a flow of 79,000 cfs at the tailwater of Keswick Dam, and (2) a stage of 39.2 feet at the Sacramento River Bend Bridge gaging station near Red Bluff (corresponding roughly to a flow of 100,000 cfs). Because of the uncontrolled nature of the inflows between Keswick Dam and Bend Bridge, the 100,000 cfs flow objective at Bend Bridge is the critical objective for minimizing flood damage. It is also important to ensure that the project does not increase potential flood damages by locating any new facilities within the 100-year floodplain or in a location that could impede or redirect flood flows, thereby potentially increasing damage to other property.

Water Supply Reliability

The CVP provides water to a range of contract types; Settlement and Exchange contractors have the highest degree of reliability because of water rights senior to the CVP. Because of their high priority, these contractors are not strongly affected by any of the SLWRI alternatives. Water service contractors and refuges are subject to shortages according to water availability and their geographic location; because of conveyance constraints, south-of-Delta water service contractors and refuges have a lower degree of reliability than North-of-Delta water service contractors and refuges. Although the SWP has several contractors north of the Delta, the vast majority of recipients of SWP water supplies are south of the Delta. SWP contractors have several types of water in their contract; the Table A contracts (DWR 2003a) are most susceptible to variability of supply.

To prevent a decrease in water supply, the SLWRI must not cause a significant reduction in long term water supply reliability to CVP and SWP contractors. For this analysis a significant reduction in long term reliability is defined as a 5 percent or greater reduction in average annual or average dry and critical year reliability. This is assumed to represent a reduction that could not reliably be replaced from other sources, such as groundwater pumping or water transfers.

Some flexibility would exist to adjust for changes in surface water supply from month to month (e.g., temporarily increased ground water pumping), but long term changes in monthly supply could have a significant impact. For this analysis a significant reduction in monthly reliability is defined as a greater than 10 percent reduction in average monthly water supply. This is assumed to represent a reduction that could not reliably be replaced from other sources, such as groundwater pumping or water transfers.

South Delta Water Levels

Water levels in the south Delta are influenced to varying degrees by natural tidal fluctuations, San Joaquin River flows, barrier operations, CVP and SWP export pumping, local agricultural diversions and drainage return flows, channel capacities, siltation, and dredging. When the CVP and SWP are exporting water, water levels in local channels can be drawn down, particularly during low water years. The South Delta Water Agency and local farmers in the south and central Delta have interests in maintaining the water levels so that their siphons and pumps, which are installed at fixed locations in the Delta, can continue to be used for irrigation diversions. The SLWRI alternatives could affect the ability of the South Delta Water Agency to divert water if changes in Delta operations reduce Delta channel water levels during the irrigation season, from April to October.

The South Delta Temporary Barriers Program was initiated by DWR in 1991 to improve water conditions in the south Delta and to provide design data for permanent gates. Since 1991, DWR has seasonally installed four barriers. Three barriers, located on the Middle River, Grant Line Canal, and Old River, ensure adequate water levels and water quality for agricultural diversions. The barriers are constructed from rock fill and incorporate overflow weirs and gated culverts. These barriers are installed in spring and removed in fall. A fourth barrier is seasonally installed at the Head of the Old River for fish control. The existing seasonal barriers significantly affect water levels in the south Delta.

To determine the potential for changes in Delta CVP/SWP operations to occur as an indirect effect of Restoration flows from the San Joaquin River reaching the Delta, analyses in the EIS compared water surface elevations simulated using DSM2 to the criteria identified in the Water Level Response Plan. The criteria identified in the plan also are applied in the EIS, such that a change in water level is considered potentially significant if the following conditions are both true:

1. The simulated water level is below 0.0 feet at msl at the Old River near Tracy Boulevard Bridge and at locations above the Grant Line Canal Barrier, or 0.3 foot above msl at the Middle River near the Howard Road Bridge. A simulated water level below these thresholds would indicate a time period when Reclamation and DWR would adjust real-time operations at Jones and Banks pumping plants to maintain consistency with the provisions of the Water Level Response Plan. Typically this would include reducing diversions at Jones and Banks pumping plants.

2. The simulated water level change between the alternative and baseline is greater than a 0.1-foot decrease during the irrigation season of April through October when the simulated water levels under the baseline conditions are below the threshold values for the three locations described above. A threshold of change of 0.1-foot was selected

because it is consistent with the level of precision provided in the water level response plan standards, and it provides a conservative threshold to identify the likelihood that real-time adjustments to CVP/SWP operations would result in water recapture from the Delta that would differ from simulated operations.

X2 Location

CCWD depends almost entirely on the Delta for water supply. CCWD's raw water system consists of four Delta pumping plants (i.e., Mallard Slough, Rock Slough, Old River, and Victoria Canal), and a 160,000-acre-feet reservoir (Los Vaqueros). The intakes on Rock Slough, Old River, and Victoria Canal are the primary source for CCWD. The fourth intake at Mallard Slough is used only when water quality conditions in the western Delta permit, usually following a prolonged period of surplus Delta outflow. Water diverted at the Old River and Victoria Canal intakes is either used directly or stored in Los Vaqueros Reservoir for later use. CCWD's current operational priority is to fill Los Vaqueros Reservoir with high quality water whenever possible.

CCWD diversions to fill Los Vaqueros Reservoir are constrained by the USFWS delta smelt BOs on operations of Los Vaqueros Reservoir (USFWS 1993 and 2011), as modified by agreements among CCWD, USFWS, CDFW, and the State Water Board. From February through May, the BO precondition for filling the reservoir is that the X2 location is west of Chipps Island. In December, January, and June, the X2 location must be west of Collinsville. Filling Los Vaqueros Reservoir is unconstrained in December if no delta smelt are present at the diversion location.

For the impact analysis, it is assumed that from February to June, the X2 requirement for filling Los Vaqueros Reservoir will be met by Reclamation and DWR as part of their responsibilities under RD-1641.[3] Changes in simulated Delta conditions are considered to be potentially significant only for the months of December and January, and only when all of the following conditions are met:

- The Delta is not in balanced condition[4]
- Under the basis of comparison, X2 is west of Collinsville
- Under the SLWRI alternatives, X2 is east of Collinsville

[3] When the Eight River Index is less than 8.1 MAF, the RD-1641 X2 requirements for May and June are relaxed, potentially impacting filling of Los Vaqueros Reservoir. Model simulations show that this would occur eight times during the simulated or historical record for water years 1922 to 1994, but in these circumstances the Delta would be in balanced water conditions.

[4] Balanced water conditions are periods when it is agreed by Reclamation and DWR that releases from upstream reservoirs plus unregulated flows approximately equal the water supply needed to meet Sacramento Valley in-basin uses plus required Delta outflows and exports (Reclamation and DWR 1986).

Reclamation and DWR are not authorized to use the JPOD when the Delta is in excess conditions, and when such diversions would cause the location of X2 to shift upstream and prevent CCWD from filling Los Vaqueros Reservoir under its water right permits.

Delta Excess Water Conditions

Changes from Delta excess water conditions to balanced conditions could adversely affect CCWD's ability to fill Los Vaqueros Reservoir. Under State Water Board Water Right Decision 1629, filling Los Vaqueros Reservoir is restricted to the parts of the period from November 1 to June 30 when the Delta is in excess water conditions. Changes in simulated Delta conditions are considered to be potentially significant if during this period the following conditions are met:

- Under the basis of comparison, the Delta is in excess conditions
- Under the SLWRI alternatives, the Delta is in balanced conditions

Groundwater Resources

Impacts on groundwater resources would be considered significant if actions related to the SLWRI alternatives would cause the groundwater resources impacts described in Table 6-3. Improvements in water supply reliability under the SLWRI alternatives may affect groundwater levels, budget, and quality in the primary and extended study areas. In general, potential impacts of the SLWRI in the primary and extended study areas would result from a reduction in water extraction because of increased surface water supply reliability. Currently, CVP and SWP water users in the primary and extended study areas pump groundwater to supplement surface water supply.

Potential impacts on groundwater resources, particularly groundwater levels, budget, and water quality, are evaluated qualitatively based on changes in surface water supply. This approach is based on the assumption that the actual reduction in groundwater extraction would be proportional to the increase in surface water supply reliability that would occur in the study areas under the SLWRI alternatives. According to the 2009 update to the California Water Plan (DWR 2009), groundwater pumping is approximately 2.6, 2.7, and 5.5 MAF per year in the Sacramento (CVP north of Delta area), San Joaquin (CVP south of Delta), and Tulare Lake (SWP agricultural deliveries south of Delta, or about half of total SWP south of Delta deliveries) basins respectively. Changes in groundwater pumping in the study areas would be relatively small compared to the estimated millions of acre-feet of annual groundwater pumping. Nevertheless, the SLWRI alternatives would have a positive, albeit limited, impact by reducing reliance on groundwater in the study areas. Because effects on groundwater basins would be limited and positive, groundwater impacts are discussed qualitatively.

6.3.3 Direct and Indirect Effects

This section describes the environmental consequences of the SLWRI alternatives, and proposed mitigation measures for any impacts determined to be significant or potentially significant. All alternatives are compared to a basis of comparison. For the existing condition (2005 level of development), a CalSim-II simulation for the existing condition is used. Similarly, the future condition (2030 level of development)[5] uses a CalSim-II simulation of the No-Action/No-Project Alternative as a basis of comparison. Each of the alternatives is simulated using the same level of development so that any changes from the basis of comparison in H&H can be attributed to the alternative.

Alternatives Description

The SLWRI alternatives are described in the following subsections.

No-Action Alternative Under the No-Action Alternative, the Federal government would take reasonably foreseeable actions, including actions with current authorization, secured funding for design and construction, and environmental permitting and compliance activities that are substantially complete. However, the Federal Government would not take additional actions toward implementing a plan to raise Shasta Dam to help increase anadromous fish survival in the upper Sacramento River, nor help address the growing water reliability issues in California. Shasta Dam would not be modified, and the CVP would continue operating similar to the existing condition. Changes in regulatory conditions and water supply demands would result in differences in flows on the Sacramento River and at the Delta between existing and future conditions. Possible changes include the following:

- Firm Level 2 Federal refuge deliveries[6]
- SWP deliveries based on full Table A amounts
- Full implementation of the Grassland Bypass Project
- Implementation of San Joaquin River flow requirements similar to the Vernalis Adaptive Management Plan

[5] The level of development used for future conditions is a composite of multiple land use scenarios developed by DWR and Reclamation. The Sacramento Valley hydrology, which includes the Sacramento and Feather River basins, is based on projected 2020 land use assumptions associated with DWR Bulletin 160-98 (1998) and the San Joaquin Valley hydrology is based on the 2030 land use assumptions developed by Reclamation. Under any 2020 to 2030 level of development scenario, the majority of the CVP and SWP unmet demand is located south of the Delta, including the San Joaquin Valley. Please see Table 2-1 in the Modeling Appendix for additional information on CalSim-II modeling assumptions.

[6] Level 2 water is the refuges' most reliable annual supply of water since Reclamation provides it to refuges from the CVP's annual water supplies. IL 4 acquisitions, however, vary from year to year, depending on annual hydrology, water availability, water market pricing, and funding. Therefore, it would be speculative to predict or assume quantities and locations of annual acquisitions from willing sellers. See Chapter 3 of the EIS for a qualitative discussion of potential effects of the action alternatives on deliveries of IL 4 water.

- Implementation of the South Bay Aqueduct Improvement and Enlargement Project
- Increased San Joaquin River diversions for water users in the Stockton Metropolitan Area after completion of the Delta Water Supply Project
- Increased Sacramento River diversions by Freeport Regional Water Project agencies
- SJRRP Full Restoration Flows

This alternative is used as a basis of comparison for future condition comparisons.

CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

CP1 focuses on increasing water supply reliability and increasing anadromous fish survival. This plan primarily consists of raising Shasta Dam by 6.5 feet, which, in combination with spillway modifications, would increase the height of the reservoir's full pool by 8.5 feet and enlarge the total storage capacity in the reservoir by 256,000 acre-feet. The existing TCD would also be extended to achieve efficient use of the expanded cold-water pool. Shasta Dam operational guidelines would continue essentially unchanged, except during dry years and critical years, when 70,000 acre-feet and 35,000 acre-feet, respectively, of the increased storage capacity in Shasta Reservoir would be reserved to specifically focus on increasing M&I deliveries. CP1 would help reduce future water shortages through increasing drought year and average year water supply reliability for agricultural and M&I deliveries. In addition, the increased depth and volume of the cold-water pool in Shasta Reservoir would contribute to improving seasonal water temperatures for anadromous fish in the upper Sacramento River.

CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

As with CP1, CP2 focuses on increasing water supply reliability and anadromous fish survival. CP2 primarily consists of raising Shasta Dam by 12.5 feet, which, in combination with spillway modifications, would increase the height of the reservoir's full pool by 14.5 feet and enlarge the total storage capacity in the reservoir by 443,000 acre-feet. The existing TCD would also be extended to achieve efficient use of the expanded cold-water pool. Shasta Dam operational guidelines would continue essentially unchanged, except during dry years and critical years, when 120,000 acre-feet and 60,000 acre-feet, respectively, of the increased storage capacity in Shasta Reservoir would be reserved to specifically focus on increasing M&I deliveries. CP2 would help reduce future water shortages through increasing drought year and average year water supply reliability for agricultural and M&I deliveries. In addition, the increased depth and volume of the cold-water pool in Shasta Reservoir would contribute to improving seasonal water temperatures for anadromous fish in the upper Sacramento River.

CP3 – 18.5-Foot Dam Raise, Agricultural Water Supply Reliability and Anadromous Fish Survival

CP3 focuses on increasing agricultural water supply reliability while also increasing anadromous fish survival. This plan primarily consists of raising Shasta Dam by 18.5 feet, which, in combination with spillway modifications, would increase the height of the reservoir's full pool by 20.5 feet and enlarge the total storage capacity in the reservoir by 634,000 acre-feet. The existing TCD would also be extended to achieve efficient use of the expanded cold-water pool. Because CP3 focuses on increasing agricultural water supply reliability, none of the increased storage capacity in Shasta Reservoir would be reserved for increasing M&I deliveries. Operations for water supply, hydropower, and environmental and other regulatory requirements would be similar to existing operations, with the additional storage retained for water supply reliability and to expand the cold-water pool for downstream anadromous fisheries.

Simulations of CP3 did not involve any changes to the modeling logic for deliveries or flow requirements; all rules for water operations were updated to include the new storage, but were not otherwise changed.

CP4 and CP4A – 18.5-Foot Dam Raise, Anadromous Fish Focus with Water Supply Reliability

CP4 and CP4A focus on increasing anadromous fish survival while also increasing water supply reliability. By raising Shasta Dam 18.5 feet, in combination with spillway modifications, both CP4 and CP4A would increase the height of the reservoir full pool by 20.5 feet and enlarge the total storage capacity in the reservoir by 634,000 acre-feet. The existing TCD would also be extended to achieve efficient use of the expanded cold-water pool. The additional storage created by the 18.5-foot dam raise would be used to improve the ability to meet temperature objectives and habitat requirements for anadromous fish during drought years and increase water supply reliability.

For CP4, about 378,000 acre-feet of the increased reservoir storage space would be dedicated to increasing the supply of cold water for anadromous fish survival purposes. Operations for the remaining portion of increased storage (approximately 256,000 acre-feet) would be the same as in CP1, with 70,000 acre-feet and 35,000 acre-feet reserved specifically to focus on increasing M&I deliveries during dry and critical years, respectively. CP4 also includes augmenting spawning gravel and restoring riparian, floodplain, and side channel habitat in the upper Sacramento River.

For CP4A, about 191,000 acre-feet of the increased reservoir storage space would be dedicated to increasing the supply of cold water for anadromous fish survival purposes. Operations for the remaining portion of increased storage (approximately 443,000 acre-feet) would be the same as in CP2 where Shasta Dam operational guidelines would continue essentially unchanged, except during dry years and critical years, when 120,000 acre-feet and 60,000 acre-feet, respectively, of the increased storage capacity in Shasta Reservoir would be reserved for M&I deliveries. CP4A would help reduce future water shortages by increasing drought year and average year water supply reliability for agricultural and M&I deliveries. Like CP4, CP4A includes augmenting spawning gravel and restoring riparian, floodplain, and side channel habitat in the upper Sacramento River for fisheries benefit.

CP5 – 18.5-Foot Dam Raise, Combination Plan

CP5 primarily focuses on increasing water supply reliability, anadromous fish survival, Shasta Lake area environmental resources, and recreation opportunities. By raising Shasta Dam 18.5 feet, in combination with spillway modifications, CP5 would increase the height of the reservoir full pool by 20.5 feet and enlarge the total storage capacity in the reservoir by 634,000 acre-feet. The existing TCD would be extended to achieve efficient use of the expanded cold-water pool. Shasta Dam operational guidelines would continue essentially unchanged, except during dry years and critical years, when 150,000 acre-feet and 75,000 acre-feet, respectively, of the increased storage capacity in Shasta Reservoir would be reserved to specifically focus on increasing M&I deliveries. CP5 also includes constructing additional fish habitat in and along the shoreline of Shasta Lake and along the lower reaches of its tributaries; augmenting spawning gravel and restoring riparian, floodplain, and side channel habitat in the upper Sacramento River; and increasing recreation opportunities at Shasta Lake.

CP5 would help reduce future water shortages through increasing drought year and average year water supply reliability for agricultural and M&I deliveries. In addition, the increased depth and volume of the cold-water pool in Shasta Reservoir would contribute to improving seasonal water temperatures for anadromous fish in the upper Sacramento River.

Changes to CVP/SWP Operations

Each of the SWLRI alternatives would have similar impacts on CVP and SWP operations compared to either the existing condition or the No-Action Alternative. However, the magnitude of the impacts would vary according to the alternative. Detailed tables of the estimated monthly flows and storages associated with each alternative, in addition to changes from the bases of comparison, are included in Attachment 1 of the Modeling Appendix. Results are summarized below.

The analysis assumed that the SLWRI alternatives would not alter existing operational rules or protocols; no formal changes to CVP or SWP operating criteria are associated with the SLWRI. At a base level, each action alternative would store some additional flows behind Shasta Dam during periods when the flows would have otherwise been released downstream. The resulting increase in storage would then be used to both create an expanded cold-water pool, thus benefiting fisheries, and for subsequent release downstream when there are opportunities to put the water to beneficial use.

Reductions in Shasta releases under the various SLWRI alternatives would typically occur during winter (November through March) in relatively wet years, and increases in releases would typically occur in the late spring and summer (June through September) of drier years. Shasta Dam typically makes releases for one of six purposes:

- Flood management
- Sacramento River flow requirements both below Keswick and at Wilkins Slough
- Sacramento River water temperature requirements at Bend Bridge
- Delta water quality requirements
- Senior water rights along the Sacramento River
- CVP water supply contracts needs both north and south of the Delta

However, release for one purpose may also be sufficient for meeting another; for instance, releases for Sacramento River water temperatures may also be used to both meet Delta water quality requirements and for export to south-of-Delta contractors. Although releases for flood management purposes typically occur in winter, water temperature and water quality requirements exist year-round. Releases for water supply purposes primarily occur in late spring, summer, and early fall.

Table 6-4 summarizes monthly flows and changes below Shasta Dam. Releases from Shasta Dam would typically be increased in the summer months, corresponding with the periods of greatest agricultural demands. Similarly, releases would be reduced in the winter months, when the increased storage would be used to capture additional runoff rather than releasing to the downstream river.

Table 6-4. Simulated Monthly Average Sacramento River Flows Below Shasta Dam

Month	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition (cfs)	Change from Base (cfs)				No-Action Alt	Change from Base (cfs)			
		CP1 and CP4	CP2 and CP4A	CP3	CP5		CP1 and CP4	CP2 and CP4A	CP3	CP5
Oct	5,023	90 (2%)	209 (4%)	196 (4%)	196 (4%)	4,998	100 (2%)	147 (3%)	139 (3%)	162 (3%)
Nov	6,056	101 (2%)	171 (3%)	154 (3%)	161 (3%)	5,895	105 (2%)	183 (3%)	234 (4%)	207 (4%)
Dec	6,321	-314 (-5%)	-392 (-6%)	-556 (-9%)	-596 (-9%)	6,182	-291 (-5%)	-470 (-8%)	-661 (-11%)	-628 (-10%)
Jan	7,244	-106 (-1%)	-244 (-3%)	-276 (-4%)	-303 (-4%)	7,218	-197 (-3%)	-265 (-4%)	-354 (-5%)	-335 (-5%)
Feb	9,408	-200 (-2%)	-287 (-3%)	-304 (-3%)	-386 (-4%)	9,463	-244 (-3%)	-366 (-4%)	-384 (-4%)	-485 (-5%)
Mar	7,704	-59 (-1%)	-138 (-2%)	-189 (-2%)	-191 (-2%)	7,710	-59 (-1%)	-137 (-2%)	-214 (-3%)	-200 (-3%)
Apr	6,541	79 (1%)	93 (1%)	139 (2%)	135 (2%)	6,427	125 (2%)	154 (2%)	205 (3%)	180 (3%)
May	7,682	-36 (0%)	-60 (-1%)	-22 (0%)	-32 (0%)	7,653	-22 (0%)	-34 (0%)	32 (0%)	3 (0%)
Jun	10,223	-7 (0%)	37 (0%)	47 (0%)	74 (1%)	10,311	80 (1%)	115 (1%)	75 (1%)	127 (1%)
Jul	11,316	131 (1%)	175 (2%)	186 (2%)	266 (2%)	11,431	14 (0%)	116 (1%)	114 (1%)	196 (2%)
Aug	8,488	51 (1%)	28 (0%)	141 (2%)	75 (1%)	8,494	120 (1%)	148 (2%)	282 (3%)	188 (2%)
Sep	6,107	136 (2%)	172 (3%)	165 (3%)	288 (5%)	6,334	146 (2%)	206 (3%)	243 (4%)	290 (5%)
Total (TAF)	5,550	-8 (0%)	-14 (0%)	-19 (0%)	-18 (0%)	5,550	-7 (0%)	-12 (0%)	-17 (0%)	-17 (0%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node C4)

Notes:
Simulation period: 1922-2003
(%) indicates percent change from either existing condition or No-Action Alternative
Key:
Alt = alternative
cfs = cubic feet per second
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre-feet

Storage in Shasta Reservoir fluctuates greatly throughout a year; storage is typically highest at the end of winter, March and April, as the need for flood control reservation space in the reservoir is reduced. Storage is typically at its lowest in October and November after the irrigation season and before the winter refill begins. As a result of the increased storage capacity attributed to each alternative, and the flow reductions described above, Shasta Reservoir storage would be generally higher under the SLWRI alternatives than under the existing condition or the No-Action Alternative (future condition). This additional storage would typically be greatest in the winter (March and April), and would be lowest at the end of summer (October or November), as shown in Table 6-5. Additional runoff captured by the increased storage increment would typically remain in storage until it could be used to meet one of the purposes described above. Conversely, under either of the bases of comparison, if water in storage were insufficient to meet all of the project purposes, the first increment to be reduced would be deliveries to water service contractors. Therefore, increased releases would typically be made on a schedule providing increased reliability of deliveries to water service contractors, typically in July through October of relatively dry years.

Table 6-5. Simulated Average End-of-Month Shasta Reservoir Storage

Month	Existing Condition (2005)							Future Condition (2030)						
	Existing Condition (TAF)	Change from Base (TAF)						No-Action Alt (TAF)	Change from Base (TAF)					
		CP1	CP2	CP3	CP4	CP4A	CP5		CP1	CP2	CP3	CP4	CP4A	CP5
Oct	2,592	148	282	399	526	473	383	2,587	141	245	366	519	436	351
Nov	2,568	142	271	390	520	462	373	2,573	134	234	351	512	425	338
Dec	2,722	161	295	424	539	486	409	2,735	152	263	392	530	454	377
Jan	2,995	167	310	440	545	501	428	3,010	164	279	413	542	470	397
Feb	3,267	178	326	457	556	517	449	3,279	178	299	435	556	490	424
Mar	3,625	182	334	468	560	525	460	3,636	181	307	447	559	498	436
Apr	3,916	177	328	459	555	519	451	3,934	173	298	434	551	489	424
May	3,941	179	330	459	557	521	452	3,961	174	299	431	552	490	423
Jun	3,639	178	327	455	556	518	447	3,653	169	291	426	547	482	414
Jul	3,160	170	315	442	548	506	428	3,167	167	283	417	545	474	401
Aug	2,834	166	312	431	544	503	422	2,841	159	273	398	537	464	387
Sep	2,669	157	301	420	535	492	404	2,662	150	260	382	528	451	369

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node S4+S44)

Note:
Simulation period: 1922-2003
Key:
Alt = alternative
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre-feet

A key indicator of water temperature benefits of the SLWRI alternatives to the Sacramento River between Keswick Dam and Red Bluff is the amount of cold water available in Shasta Reservoir before the water temperature operation season, about May through October. As previously described, Shasta Reservoir generally reaches its maximum storage during late April or early May. Also, the cold-water pool volume in the lake accumulates during the winter and early spring and is not likely to increase after April. Therefore, the expected increase in spring storage for each dam raise alternative should also result in an incremental increase in the cold-water pool volume.

Reclamation operates the Shasta Dam TCD to manage water temperatures in the Sacramento River to: (1) improve habitat for the endangered winter-run Chinook salmon and other threatened runs, (2) withdraw warmer surface water in the winter and spring to preserve cold-water storage for release during the temperature operation season, and (3) enable power generation to continue while controlling release temperatures, which eliminates the need to bypass the powerplant penstocks via the low-level river outlets. Generally, to accomplish these temperature objectives during the temperature operation season, the TCD functions to select water temperatures in the 47 degrees Fahrenheit (°F) to 52°F range. Therefore, a good index of the temperature-related benefits of the alternative is the volume of the cold-water pool less than 52°F at the end of April. In the context of historical project operation, reservoir storage and cold-water pool conditions in mid-spring represent the available cold-water "bank" managed throughout the temperature operation season (July through October), as prescribed by the SRTTG. The simulated end-of-April volume of water less than 52°F for the two bases of comparison, and the change in cold-water pool volume for each of the SLWRI alternatives, are shown by Sacramento Valley Index in Table 6-6. As expected, the higher dam raise alternatives generally reflect a larger cold-water pool volume.

Table 6-6. Simulated Average Volume of Water Less than 52˚F in Shasta Reservoir at the End of April

Year Type[1]	Existing Condition (2005)							Future Condition (2030)						
	Existing Condition (TAF)	Change from Base (TAF)						No-Action Alt (TAF)	Change from Base (TAF)					
		CP1	CP2	CP3	CP4	CP4A	CP5		CP1	CP2	CP3	CP4	CP4A	CP5
Average of All Years	2,609	142	267	385	470	435	378	2,628	137	241	357	457	405	349
Wet	2,804	186	331	500	510	504	500	2,799	189	339	498	506	499	498
Above Normal	2,972	163	296	432	502	465	439	2,979	161	289	430	489	450	423
Below Normal	2,699	129	263	382	462	434	357	2,736	130	225	337	463	400	339
Dry	2,542	130	231	322	441	384	317	2,562	100	181	261	398	332	266
Critical	1,601	49	134	151	364	296	142	1,659	50	70	117	365	235	59

Source: Benchmark Study Team April 2010 Version SRWQM 2005 and 2030 simulations
Notes:
Simulation period: 1922-2003
[1] Water year types as defined by the Sacramento Valley Index
Key:
ºF = degrees Fahrenheit
Alt =alternative
CP = comprehensive plan
TAF = thousand acre-feet

Downstream from Shasta Dam, the Sacramento River combines with releases from Trinity Reservoir through Whiskeytown Reservoir and Spring Creek Tunnel above Keswick Dam. Because of the connected nature of Shasta Reservoir and Trinity Reservoir for meeting instream flow requirements and water supply demands below Keswick Dam, changes in Shasta Reservoir operations would possibly result in changes to operations of Trinity Reservoir. Table 6-7 shows changes in Trinity Reservoir storage and Trinity River flows below Lewiston that would result from SLWRI alternatives. These changes are small relative to the reservoir storage and should not result in noticeable changes at Trinity Reservoir. To limit the effect of the enlarged Shasta Reservoir on Trinity Reservoir operations, the relationship in CalSim-II between Shasta Reservoir storage and Trinity Reservoir exports to the Sacramento River was modified through interpolation to approximately maintain the export level of the basis of comparison in the action alternatives.

Table 6-7. Simulated Average End-of-Month Trinity Lake Storage and Trinity River Flow Below Lewiston

Month	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition	Change from Base				No-Action Alt	Change from Base			
		CP1 and CP4	CP2 and CP4A	CP3	CP5		CP1 and CP4	CP2 and CP4A	CP3	CP5
End-of-Month Trinity Lake Storage (TAF)										
Oct	1,323	17 (1%)	19 (1%)	32 (2%)	20 (2%)	1,328	15 (1%)	6 (0%)	17 (1%)	5 (0%)
Nov	1,331	18 (1%)	21 (2%)	35 (3%)	23 (2%)	1,353	16 (1%)	8 (1%)	19 (1%)	7 (1%)
Dec	1,382	17 (1%)	19 (1%)	33 (2%)	22 (2%)	1,404	16 (1%)	7 (1%)	18 (1%)	6 (0%)
Jan	1,444	18 (1%)	22 (2%)	38 (3%)	26 (2%)	1,467	17 (1%)	11 (1%)	23 (2%)	11 (1%)
Feb	1,553	17 (1%)	21 (1%)	36 (2%)	24 (2%)	1,575	15 (1%)	9 (1%)	21 (1%)	10 (1%)
Mar	1,676	15 (1%)	18 (1%)	32 (2%)	20 (1%)	1,695	12 (1%)	7 (0%)	15 (1%)	5 (0%)
Apr	1,826	19 (1%)	23 (1%)	35 (2%)	25 (1%)	1,849	18 (1%)	13 (1%)	22 (1%)	12 (1%)
May	1,820	19 (1%)	23 (1%)	35 (2%)	24 (1%)	1,843	17 (1%)	12 (1%)	21 (1%)	12 (1%)
Jun	1,783	19 (1%)	22 (1%)	33 (2%)	23 (1%)	1,807	18 (1%)	12 (1%)	19 (1%)	11 (1%)
Jul	1,646	18 (1%)	20 (1%)	33 (2%)	23 (1%)	1,669	14 (1%)	9 (1%)	17 (1%)	9 (1%)
Aug	1,511	19 (1%)	19 (1%)	32 (2%)	22 (1%)	1,531	17 (1%)	11 (1%)	20 (1%)	10 (1%)
Sep	1,388	18 (1%)	18 (1%)	29 (2%)	20 (1%)	1,407	16 (1%)	7 (0%)	18 (1%)	6 (0%)
Trinity River Flow Below Lewiston (cfs)										
Oct	373	0 (0%)	0 (0%)	0 (0%)	0 (0%)	368	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Nov	360	4 (1%)	4 (1%)	4 (1%)	4 (1%)	360	-2 (0%)	-2 (-1%)	-1 (0%)	-2 (-1%)
Dec	518	-9 (-2%)	-14 (-3%)	-2 (0%)	-5 (-1%)	511	-8 (-2%)	-10 (-2%)	-10 (-2%)	-10 (-2%)
Jan	646	20 (3%)	18 (3%)	18 (3%)	18 (3%)	659	13 (2%)	-2 (0%)	-5 (-1%)	-7 (-1%)
Feb	648	1 (0%)	3 (0%)	15 (2%)	7 (1%)	642	8 (1%)	-1 (0%)	7 (1%)	-8 (-1%)
Mar	595	24 (4%)	19 (3%)	40 (7%)	37 (6%)	581	31 (5%)	20 (3%)	62 (11%)	57 (10%)
Apr	554	6 (1%)	6 (1%)	6 (1%)	6 (1%)	558	3 (0%)	3 (0%)	3 (0%)	-2 (0%)
May	3,779	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3,779	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Jun	2,092	2 (0%)	2 (0%)	2 (0%)	2 (0%)	2,091	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Jul	923	0 (0%)	0 (0%)	0 (0%)	0 (0%)	923	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Aug	450	0 (0%)	0 (0%)	0 (0%)	0 (0%)	450	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Sep	450	0 (0%)	0 (0%)	0 (0%)	0 (0%)	450	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Total (TAF)	690	3 (0%)	2 (0%)	5 (1%)	4 (1%)	689	3 (0%)	1 (0%)	3 (0%)	2 (0%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node S1)

Notes:
Simulation period: 1922-2003
(%) indicates percent change from either existing condition or No-Action Alternative

Key:
Alt =alternative
cfs = cubic-feet per second
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre-feet

Below Keswick Dam, Sacramento River flows would be increasingly affected by tributary inflows rather than releases from Shasta Lake. Table 6-8 shows the input monthly average tributary inflows to the Sacramento River between Keswick Dam and RBPP. The tributary inflows are consistent between the 2005 and 2030 levels of development simulations and for each alternative. Below RBPP, flow changes associated with the SLWRI alternatives would be considerably smaller relative to total flow in the river.

Table 6-8. Input Monthly Average Tributary Inflow to the Sacramento River Between Keswick Dam and Red Bluff Pumping Plant

Month	Cottonwood Creek (cfs)	Paynes Creek (cfs)
Oct	109	23
Nov	335	77
Dec	1,073	145
Jan	1,848	179
Feb	2,252	174
Mar	1,803	128
Apr	1,139	70
May	619	37
Jun	298	23
Jul	108	10
Aug	64	7
Sep	70	13
Total (AF)	584,937	53,402

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node I108 and I110)

Note:
Simulation period: 1922-2003
Key:
AF = acre-feet
cfs = cubic feet per second
SLWRI = Shasta Lake Water Resources Investigation

Tributary influence on Sacramento River monthly average flows is apparent when existing condition and No-Action Alternative total flows are compared (see Tables 6-4 and 6-9). Total flows are greater downstream from RBPP, after several tributaries have entered the Sacramento River, than they are immediately downstream from Shasta Dam.

Table 6-9. Simulated Monthly Average Sacramento River Flows Below Red Bluff Pumping Plant

Month	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition (cfs)	Change from Base (cfs)				No-Action Alts (cfs)	Change from Base (cfs)			
		CP1 and CP4	CP2 and CP4A	CP3	CP5		CP1 and CP4	CP2 and CP4A	CP3	CP5
Oct	6,959	90 (1%)	180 (3%)	131 (2%)	179 (3%)	6,927	117 (2%)	147 (2%)	142 (2%)	180 (3%)
Nov	8,802	88 (1%)	142 (2%)	129 (1%)	114 (1%)	8,721	81 (1%)	155 (2%)	200 (2%)	165 (2%)
Dec	11,683	-291 (-2%)	-348 (-3%)	-518 (-4%)	-574 (-5%)	11,595	-280 (-2%)	-450 (-4%)	-627 (-5%)	-599 (-5%)
Jan	15,241	-138 (-1%)	-291 (-2%)	-354 (-2%)	-365 (-2%)	15,245	-228 (-1%)	-319 (-2%)	-425 (-3%)	-404 (-3%)
Feb	18,111	-189 (-1%)	-272 (-2%)	-292 (-2%)	-372 (-2%)	18,186	-212 (-1%)	-339 (-2%)	-366 (-2%)	-465 (-3%)
Mar	14,544	-48 (0%)	-121 (-1%)	-168 (-1%)	-168 (-1%)	14,586	-37 (0%)	-110 (-1%)	-179 (-1%)	-175 (-1%)
Apr	10,615	-7 (0%)	-4 (0%)	52 (0%)	33 (0%)	10,580	19 (0%)	41 (0%)	81 (1%)	50 (0%)
May	9,551	-50 (-1%)	-76 (-1%)	-73 (-1%)	-78 (-1%)	9,554	-39 (0%)	-56 (-1%)	-31 (0%)	-46 (0%)
Jun	10,903	-3 (0%)	15 (0%)	-2 (0%)	42 (0%)	10,971	56 (1%)	70 (1%)	17 (0%)	68 (1%)
Jul	12,424	107 (1%)	163 (1%)	81 (1%)	186 (1%)	12,510	48 (0%)	117 (1%)	42 (0%)	143 (1%)
Aug	9,782	22 (0%)	13 (0%)	55 (1%)	16 (0%)	9,863	57 (1%)	103 (1%)	159 (2%)	114 (1%)
Sep	8,009	141 (2%)	178 (2%)	200 (3%)	328 (4%)	8,271	151 (2%)	248 (3%)	240 (3%)	344 (4%)
Total (TAF)	8,217	-16 (0%)	-25 (0%)	-46 (-1%)	-39 (0%)	8,240	-16 (0%)	-23 (0%)	-45 (-1%)	-37 (0%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node C112)

Notes:
Simulation period: 1922-2003
(%) indicates percent change from either existing condition or No-Action Alternative

Key:
Alt = alternative
cfs = cubic feet per second
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre-feet

In addition to the multiple tributary inflows between Keswick Dam and Red Bluff, downstream flows on the Sacramento River would be affected by diversions above RBPP. Specifically, contractors off Tehama-Colusa Canal receive supplies from above the RBPP. Because contractors off Tehama-Colusa Canal are all water service contractors, and thus would be subject to delivery shortages when CVP storage is low, the SLWRI alternatives would result in increased deliveries to Tehama-Colusa Canal contractors in relatively dry years. Table 6-10 shows simulated diversions from RBPP to Tehama-Colusa Canal in dry and critical years. Agricultural diversions typically occur between April and September, with some additional diversions in March and October; accordingly, deliveries on Tehama-Colusa Canal increase in the agricultural diversion months, but see no changes in other months with little or no irrigation.

Table 6-10. Simulated Monthly Average Diversions to Tehama-Colusa Canal in Dry and Critical Years

Month	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition (cfs)	Change from Base (cfs)				No-Action Alt (cfs)	Change from Base (cfs)			
		CP1 and CP4	CP2 and CP4A	CP3	CP5		CP1 and CP4	CP2 and CP4A	CP3	CP5
Oct	111	2 (2%)	2 (2%)	7 (7%)	5 (4%)	106	1 (1%)	3 (3%)	8 (8%)	6 (5%)
Nov	10	0 (0%)	0 (1%)	0 (3%)	0 (2%)	10	0 (0%)	0 (1%)	0 (3%)	0 (2%)
Dec	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Jan	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Feb	7	0 (1%)	0 (0%)	0 (2%)	0 (1%)	5	0 (0%)	0 (0%)	0 (1%)	0 (1%)
Mar	21	2 (10%)	2 (11%)	7 (31%)	5 (23%)	15	1 (9%)	2 (16%)	7 (47%)	5 (34%)
Apr	154	10 (6%)	15 (10%)	39 (26%)	31 (20%)	129	2 (2%)	-3 (-3%)	21 (17%)	10 (8%)
May	252	22 (9%)	28 (11%)	64 (25%)	58 (23%)	219	16 (7%)	23 (10%)	69 (31%)	50 (23%)
Jun	438	24 (6%)	30 (7%)	82 (19%)	64 (15%)	430	12 (3%)	27 (6%)	86 (20%)	64 (15%)
Jul	497	26 (5%)	32 (7%)	92 (19%)	69 (14%)	437	13 (3%)	30 (7%)	98 (22%)	70 (16%)
Aug	450	21 (5%)	26 (6%)	73 (16%)	55 (12%)	403	11 (3%)	24 (6%)	78 (19%)	56 (14%)
Sep	108	10 (9%)	20 (18%)	33 (31%)	27 (25%)	90	7 (8%)	15 (17%)	30 (34%)	26 (29%)
Total (TAF)	125	7 (6%)	9 (8%)	24 (19%)	19 (15%)	112	4 (3%)	7 (7%)	24 (22%)	17 (16%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node D112)

Notes:
Simulation period: 1922-2003
Dry and critical years as defined by the Sacramento Valley Index
(%) indicates percent change from either existing condition or No-Action Alternative

Key:
Alt = alternative
cfs = cubic feet per second
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre-feet

Although Tehama-Colusa Canal water users are the primary recipient of CVP water service contract deliveries north of the Delta, other north-of-the-Delta users are subject to changes in water supply, including wildlife refuges. Average monthly deliveries to CVP water service contractors and refuges north of the Delta are included in Table 6-11.

Table 6-11. Simulated Monthly Average Deliveries to North-of-Delta CVP Water Service Contractors and Refuges

Month	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition	Change from Base				No-Action Alt	Change from Base			
		CP1 and CP4	CP2 and CP4A	CP3	CP5		CP1 and CP4	CP2 and CP4A	CP3	CP5
North-of-Delta CVP Water Service Contractors Deliveries (cfs)										
Oct	77	3 (3%)	4 (5%)	8 (11%)	7 (9%)	74	2 (3%)	4 (6%)	9 (12%)	7 (10%)
Nov	3	0 (1%)	0 (4%)	0 (11%)	0 (8%)	2	0 (2%)	0 (5%)	0 (12%)	0 (9%)
Dec	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Jan	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Feb	3	0 (2%)	0 (1%)	0 (4%)	0 (3%)	2	0 (1%)	0 (2%)	0 (5%)	0 (4%)
Mar	19	1 (5%)	2 (8%)	5 (24%)	4 (18%)	15	1 (5%)	2 (12%)	5 (32%)	4 (24%)
Apr	335	12 (3%)	19 (6%)	44 (13%)	34 (10%)	297	13 (4%)	23 (8%)	47 (16%)	38 (13%)
May	572	15 (3%)	24 (4%)	60 (10%)	46 (8%)	555	15 (3%)	30 (5%)	68 (12%)	54 (10%)
Jun	799	19 (2%)	30 (4%)	76 (10%)	58 (7%)	788	19 (2%)	37 (5%)	86 (11%)	67 (8%)
Jul	918	21 (2%)	33 (4%)	86 (9%)	64 (7%)	910	20 (2%)	40 (4%)	97 (11%)	74 (8%)
Aug	733	17 (2%)	26 (4%)	68 (9%)	50 (7%)	727	16 (2%)	31 (4%)	77 (11%)	58 (8%)
Sep	341	8 (2%)	12 (4%)	30 (9%)	22 (7%)	334	8 (2%)	15 (4%)	34 (10%)	26 (8%)
Total (TAF)	231	6 (2%)	9 (4%)	23 (10%)	17 (8%)	225	6 (3%)	11 (5%)	26 (11%)	20 (9%)
North-of-Delta Refuges Deliveries (cfs)										
Oct	177	-10 (-5%)	-8 (-4%)	-7 (-4%)	-10 (-6%)	224	2 (1%)	2 (1%)	9 (4%)	-4 (-2%)
Nov	168	2 (1%)	3 (2%)	1 (0%)	0 (0%)	219	-1 (0%)	1 (0%)	0 (0%)	1 (1%)
Dec	105	0 (0%)	0 (0%)	0 (0%)	0 (0%)	133	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Jan	50	0 (0%)	0 (0%)	0 (0%)	0 (0%)	63	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Feb	45	0 (0%)	0 (0%)	0 (0%)	0 (0%)	57	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Mar	13	0 (0%)	0 (0%)	0 (0%)	0 (0%)	16	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Apr	15	0 (0%)	0 (0%)	0 (0%)	0 (0%)	18	0 (0%)	0 (-1%)	0 (-1%)	0 (-1%)
May	50	-1 (-1%)	0 (0%)	0 (0%)	0 (0%)	64	0 (0%)	0 (0%)	0 (0%)	0 (-1%)
Jun	79	-1 (-1%)	-1 (-1%)	-1 (-1%)	-1 (-1%)	96	1 (1%)	1 (1%)	1 (1%)	1 (1%)
Jul	106	-1 (-1%)	0 (0%)	-1 (-1%)	-1 (-1%)	134	-1 (-1%)	-1 (-1%)	-1 (-1%)	1 (1%)
Aug	143	0 (0%)	-1 (-1%)	-2 (-1%)	0 (0%)	180	2 (1%)	3 (2%)	1 (1%)	3 (2%)
Sep	187	0 (0%)	0 (0%)	0 (0%)	0 (0%)	237	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Total (TAF)	69	-1 (-1%)	0 (-1%)	-1 (-1%)	-1 (-1%)	87	0 (0%)	0 (0%)	1 (1%)	0 (0%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Nodes DEL_CVP_PAG_N and DEL_CVP_PRF_N)

Notes:
Simulation period: 1922-2003
(%) indicates percent change from either existing condition or No-Action Alternative

Key:
Alt = alternative
cfs = cubic feet per second
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre-feet

As would be expected, the change in deliveries to water service contractors increases with the greater enlargement volumes, and increases in deliveries are much greater in the dry and critical years than in average years, corresponding to the increased likelihood of shortages during drier periods. On a long-term average basis, there would be no significant change in deliveries to refuges. Minor increases and decreases in Refuge deliveries are not a true representation of real-time operations but an indication of modeling artifacts. Such reduction would not occur in real time due to efficient water allocation and management schemes that can be captured adequately in a water resources planning model such as CalSim-II. Table 6-12 shows average deliveries to water service contractors and refuges north of Delta in dry and critical years.

Table 6-12. Simulated Monthly Average Deliveries to North-of-Delta CVP Water Service Contractors and Refuges in Dry and Critical Years-updated

Month	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition	Change from Base				No-Action Alt	Change from Base			
		CP1 and CP4	CP2 and CP4A	CP3	CP5		CP1 and CP4	CP2 and CP4A	CP3	CP5
North-of-Delta CVP Water Service Contractors (cfs)										
Oct	69	3 (4%)	3 (5%)	9 (13%)	6 (9%)	63	2 (3%)	4 (6%)	10 (16%)	7 (12%)
Nov	3	0 (2%)	0 (6%)	1 (16%)	0 (13%)	3	0 (2%)	0 (9%)	1 (21%)	0 (16%)
Dec	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Jan	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Feb	7	0 (1%)	0 (0%)	0 (2%)	0 (1%)	5	0 (0%)	0 (0%)	0 (1%)	0 (1%)
Mar	21	2 (10%)	2 (11%)	7 (33%)	5 (24%)	14	1 (10%)	2 (17%)	7 (53%)	5 (38%)
Apr	229	14 (6%)	21 (9%)	53 (23%)	42 (18%)	181	11 (6%)	21 (12%)	57 (31%)	43 (24%)
May	316	19 (6%)	25 (8%)	69 (22%)	52 (16%)	268	11 (4%)	24 (9%)	75 (28%)	55 (20%)
Jun	425	26 (6%)	32 (8%)	90 (21%)	68 (16%)	365	13 (4%)	30 (8%)	95 (26%)	69 (19%)
Jul	480	29 (6%)	36 (7%)	101 (21%)	76 (16%)	414	15 (4%)	33 (8%)	108 (26%)	77 (19%)
Aug	386	23 (6%)	29 (7%)	81 (21%)	61 (16%)	333	12 (4%)	27 (8%)	87 (26%)	62 (19%)
Sep	170	11 (6%)	14 (8%)	36 (21%)	27 (16%)	144	6 (4%)	12 (8%)	39 (27%)	27 (19%)
Total (TAF)	128	8 (6%)	10 (8%)	27 (21%)	21 (16%)	109	4 (4%)	9 (9%)	29 (27%)	21 (19%)
North-of-Delta Refuges Deliveries (cfs)										
Oct	182	-25 (-14%)	-17 (-9%)	-13 (-7%)	-31 (-17%)	212	8 (4%)	12 (5%)	30 (14%)	-4 (-2%)
Nov	156	5 (3%)	11 (7%)	3 (2%)	4 (3%)	212	-4 (-2%)	-2 (-1%)	-4 (-2%)	0 (0%)
Dec	104	0 (0%)	0 (0%)	0 (0%)	0 (0%)	132	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Jan	50	0 (0%)	0 (0%)	0 (0%)	0 (0%)	62	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Feb	45	0 (0%)	0 (0%)	0 (0%)	0 (0%)	57	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Mar	12	0 (0%)	0 (1%)	0 (-1%)	0 (-1%)	15	0 (1%)	0 (1%)	0 (-1%)	0 (1%)
Apr	14	0 (0%)	0 (1%)	0 (1%)	0 (0%)	17	0 (-1%)	0 (-1%)	0 (-2%)	0 (-2%)
May	46	-2 (-3%)	0 (0%)	0 (0%)	0 (0%)	59	0 (0%)	0 (0%)	0 (0%)	-1 (-2%)
Jun	75	-2 (-3%)	-3 (-4%)	-2 (-3%)	-2 (-3%)	87	3 (3%)	3 (3%)	4 (5%)	3 (3%)
Jul	99	-3 (-3%)	0 (0%)	-1 (-1%)	-3 (-3%)	126	-4 (-3%)	-4 (-3%)	-2 (-2%)	2 (2%)
Aug	134	0 (0%)	-2 (-2%)	-5 (-3%)	0 (0%)	165	6 (4%)	9 (6%)	3 (2%)	9 (6%)
Sep	177	0 (0%)	0 (0%)	0 (0%)	0 (0%)	226	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Total (TAF)	66	-2 (-2%)	-1 (-1%)	-1 (-2%)	-2 (-3%)	83	1 (1%)	1 (1%)	2 (2%)	1 (1%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Nodes DEL_CVP_PAG_N and DEL_CVP_PRF_N)
Notes:
Simulation period: 1922-2003
(%) indicates percent change from either existing condition or No-Action Alternative
Dry and critical years as defined by the Sacramento Valley Index

Key:
Alt = alternative
cfs = cubic feet per second
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre-feet

Table 6-13 shows the input monthly average tributary inflows to the Sacramento River below RBPP. The tributary inflows are the same in the 2005 and 2030 levels of development simulations.

Table 6-13. Input Monthly Average Tributary Inflow to the Sacramento River Below Red Bluff Pumping Plant

Month	Thomes and Elder Creeks (cfs)	Antelope, Mill, and Deer Creeks (cfs)
Oct	32	397
Nov	227	712
Dec	626	1,412
Jan	881	1,878
Feb	1,115	2,122
Mar	976	1,919
Apr	791	1,699
May	503	1,350
Jun	172	817
Jul	36	454
Aug	8	350
Sep	10	335
Total (TAF)	323,806	811,287

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node I1301 and I1305)

Note:

Simulation period: 1922-2003

Key:

AF = acre-feet

cfs = cubic feet per second

SLWRI = Shasta Lake Water Resources Investigation

TAF = thousand acre-feet

As described in Chapter 1 of the *Hydrology, Hydraulics, and Water Management Technical Report*, during high flow periods, Sacramento River flows below Red Bluff can be diverted into the Sutter Bypass near Ord Ferry, or from the Moulton, Colusa, or Tisdale weirs. Similarly, flows can be diverted into the Yolo Bypass from the Fremont and Sacramento weirs. Table 6-14 shows the recurrence of annual spills over the various Sacramento Valley weirs into the Sutter and Yolo bypasses.

Table 6-14. Simulated Number of Years of Sacramento Valley Weir Spill

Location	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition	Change from Base				No-Action Alt	Change from Base			
		CP1 and CP4	CP2 and CP4A	CP3	CP5		CP1 and CP4	CP2 and CP4A	CP3	CP5
Spill Above Moulton Weir	2	0	0	0	0	2	0	0	0	0
Moulton Weir	15	0	0	0	0	16	-1	-1	-1	-2
Colusa Weir	39	-1	-2	-2	-3	39	-2	-2	-3	-4
Tisdale Weir	53	-1	-1	-1	-1	54	0	0	-1	-1
Fremont Weir	49	0	0	0	0	48	0	1	0	0
Sacramento Weir	50	0	0	1	0	49	0	1	1	1

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node D117, D124, D125, D126, D160, D166A)
Note:
Simulation period: 1922-2003
Key:
Alt = alternative
cfs = cubic feet per second
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation

As the Sacramento River nears the Delta, the basis-of-comparison flow would increase considerably so that flow changes associated with SLWRI alternatives would be miniscule in most months. Table 6-15 shows the simulated monthly average Sacramento River flow below Freeport. Flow changes because of each alternative are small compared to the bases of comparison; average monthly flow changes are typically between 0 percent and 2 percent. Larger flow increases are because of operations specifically for export; since conditions typically only allow for increased exports in July, August, and September, the majority of the changes are observed during those months.

Table 6-15. Simulated Monthly Average Sacramento River Flows Below Freeport

Month	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition (cfs)	Change from Base (cfs)				No-Action Alt	Change from Base (cfs)			
		CP1 and CP4	CP2 and CP4A	CP3	CP5		CP1 and CP4	CP2 and CP4A	CP3	CP5
Oct	11,309	80 (1%)	92 (1%)	107 (1%)	107 (1%)	11,117	67 (1%)	94 (1%)	102 (1%)	113 (1%)
Nov	15,640	37 (0%)	95 (1%)	63 (0%)	70 (0%)	15,605	25 (0%)	95 (1%)	119 (1%)	89 (1%)
Dec	23,248	-67 (0%)	-22 (0%)	-92 (0%)	-106 (0%)	23,229	-55 (0%)	-105 (0%)	-133 (-1%)	-139 (-1%)
Jan	31,139	5 (0%)	-77 (0%)	-70 (0%)	-93 (0%)	31,167	-31 (0%)	-61 (0%)	-106 (0%)	-91 (0%)
Feb	36,608	-41 (0%)	-12 (0%)	-30 (0%)	-49 (0%)	36,618	-32 (0%)	-56 (0%)	-84 (0%)	-129 (0%)
Mar	32,396	-29 (0%)	-64 (0%)	-54 (0%)	-95 (0%)	32,352	-9 (0%)	-34 (0%)	-90 (0%)	-68 (0%)
Apr	23,232	10 (0%)	14 (0%)	49 (0%)	58 (0%)	23,206	16 (0%)	41 (0%)	87 (0%)	51 (0%)
May	19,417	-48 (0%)	-76 (0%)	-65 (0%)	-68 (0%)	19,114	-45 (0%)	-68 (0%)	-49 (0%)	-59 (0%)
Jun	16,508	-54 (0%)	-53 (0%)	-33 (0%)	-56 (0%)	16,511	-23 (0%)	-48 (0%)	-62 (0%)	-90 (-1%)
Jul	19,518	12 (0%)	32 (0%)	11 (0%)	60 (0%)	19,266	37 (0%)	67 (0%)	54 (0%)	119 (1%)
Aug	14,710	33 (0%)	11 (0%)	-15 (0%)	7 (0%)	14,596	41 (0%)	67 (0%)	94 (1%)	101 (1%)
Sep	18,211	102 (1%)	127 (1%)	46 (0%)	237 (1%)	18,417	146 (1%)	251 (1%)	127 (1%)	316 (2%)
Total (TAF)	15,742	2 (0%)	4 (0%)	-5 (0%)	4 (0%)	15,696	8 (0%)	15 (0%)	4 (0%)	13 (0%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node C169)

Notes:
Simulation period: 1922-2003
(%) indicates percent change from either existing condition or No-Action Alternative
Key:
Alt = alternative
cfs = cubic feet per second
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre-feet

Because of the interconnected nature of CVP and SWP operations for meeting shared Sacramento River flow requirements and Delta water quality obligations, changes in Shasta Reservoir operations could potentially affect operations of both Oroville Reservoir on the Feather River and Folsom Reservoir on the American River. For example, an increase in Shasta Reservoir releases may create opportunities for increased SWP export of releases from Oroville Reservoir by improving Delta water quality. Tables 6-16 and 6-17 show simulated end-of-month storage at Oroville Reservoir and Feather River flow below the Thermalito Afterbay, respectively.

Table 6-16. Simulated Average End-of-Month Oroville Reservoir Storage

Month	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition (TAF)	Change from Base (TAF)				No-Action Alt (TAF)	Change from Base			
		CP1 and CP4	CP2 and CP4A	CP3	CP5		CP1 and CP4	CP2 and CP4A	CP3	CP5
Oct	1,789	8 (0%)	15 (1%)	2 (0%)	17 (1%)	1,737	8 (0%)	13 (1%)	2 (0%)	15 (1%)
Nov	1,845	6 (0%)	12 (1%)	0 (0%)	14 (1%)	1,796	8 (0%)	13 (1%)	2 (0%)	14 (1%)
Dec	1,965	5 (0%)	10 (0%)	1 (0%)	11 (1%)	1,929	7 (0%)	12 (1%)	0 (0%)	13 (1%)
Jan	2,173	4 (0%)	9 (0%)	0 (0%)	11 (0%)	2,143	8 (0%)	13 (1%)	0 (0%)	14 (1%)
Feb	2,381	3 (0%)	8 (0%)	0 (0%)	9 (0%)	2,365	7 (0%)	12 (1%)	1 (0%)	14 (1%)
Mar	2,591	3 (0%)	8 (0%)	-1 (0%)	9 (0%)	2,581	6 (0%)	10 (0%)	3 (0%)	11 (0%)
Apr	2,866	3 (0%)	8 (0%)	-1 (0%)	9 (0%)	2,857	6 (0%)	10 (0%)	3 (0%)	12 (0%)
May	2,998	4 (0%)	8 (0%)	-1 (0%)	9 (0%)	2,992	5 (0%)	10 (0%)	3 (0%)	11 (0%)
Jun	2,894	7 (0%)	13 (0%)	-2 (0%)	16 (1%)	2,877	9 (0%)	16 (1%)	2 (0%)	19 (1%)
Jul	2,427	9 (0%)	17 (1%)	-1 (0%)	20 (1%)	2,408	9 (0%)	14 (1%)	-1 (0%)	16 (1%)
Aug	2,150	9 (0%)	16 (1%)	0 (0%)	19 (1%)	2,113	11 (1%)	17 (1%)	3 (0%)	19 (1%)
Sep	1,856	8 (0%)	14 (1%)	4 (0%)	17 (1%)	1,794	8 (0%)	11 (1%)	2 (0%)	13 (1%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node S6)
Note:
Simulation period: 1922-2003
(%) indicates percent change from either existing condition or No-Action Alternative
Key:
Alt = alternative
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre-feet

Table 6-17. Simulated Monthly Average Feather River Flow Below the Thermalito Afterbay

Month	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition (cfs)	Change from Base (cfs)				No-Action Alt (cfs)	Change from Base (cfs)			
		CP1 and CP4	CP2 and CP4A	CP3	CP5		CP1 and CP4	CP2 and CP4A	CP3	CP5
Oct	2,924	-15 (-1%)	-22 (-1%)	35 (1%)	-13 (0%)	2,778	-11 (0%)	-27 (-1%)	10 (0%)	-35 (-1%)
Nov	2,231	31 (1%)	36 (2%)	24 (1%)	42 (2%)	2,165	7 (0%)	11 (1%)	1 (0%)	23 (1%)
Dec	3,742	34 (1%)	46 (1%)	-18 (0%)	65 (2%)	3,523	13 (0%)	7 (0%)	27 (1%)	15 (0%)
Jan	4,551	16 (0%)	18 (0%)	18 (0%)	14 (0%)	4,453	-5 (0%)	-15 (0%)	-7 (0%)	-3 (0%)
Feb	5,582	10 (0%)	23 (0%)	-1 (0%)	25 (0%)	5,354	11 (0%)	11 (0%)	-15 (0%)	1 (0%)
Mar	5,962	0 (0%)	3 (0%)	17 (0%)	-2 (0%)	5,854	26 (0%)	34 (1%)	-20 (0%)	41 (1%)
Apr	3,058	1 (0%)	1 (0%)	1 (0%)	1 (0%)	3,063	-4 (0%)	-5 (0%)	-3 (0%)	-7 (0%)
May	3,725	-3 (0%)	-2 (0%)	-1 (0%)	0 (0%)	3,684	9 (0%)	7 (0%)	-8 (0%)	9 (0%)
Jun	3,575	-66 (-2%)	-91 (-3%)	24 (1%)	-114 (-3%)	3,746	-68 (-2%)	-104 (-3%)	22 (1%)	-135 (-4%)
Jul	7,478	-38 (-1%)	-75 (-1%)	-19 (0%)	-77 (-1%)	7,512	2 (0%)	29 (0%)	47 (1%)	41 (1%)
Aug	4,557	4 (0%)	19 (0%)	-21 (0%)	17 (0%)	4,855	-33 (-1%)	-51 (-1%)	-71 (-1%)	-55 (-1%)
Sep	5,301	14 (0%)	38 (1%)	-67 (-1%)	31 (1%)	5,699	53 (1%)	92 (2%)	26 (0%)	95 (2%)
Total (TAF)	3,178	-1 (0%)	0 (0%)	0 (0%)	-1 (0%)	3,178	0 (0%)	-1 (0%)	1 (0%)	-1 (0%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node C203)

Notes:
Simulation period: 1922-2003
(%) indicates percent change from either existing condition or No-Action Alternative
Key:
Alt = alternative
cfs = cubic feet per second
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre-feet

Similarly, an increase in Shasta Reservoir releases in a particular month may result in improved Delta water quality, allowing for a possible reduction in CVP releases from the American River, and a corresponding increase in Folsom Reservoir storage. Tables 6-18 and 6-19 show simulated end-of-month storage at Folsom Reservoir and on the American River near the H-Street Bridge, respectively.

Table 6-18. Simulated Average End-of-Month Folsom Reservoir Storage

Month	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition (TAF)	Change from Base (TAF)				No-Action Alt (TAF)	Change from Base (TAF)			
		CP1 and CP4	CP2 and CP4A	CP3	CP5		CP1 and CP4	CP2 and CP4A	CP3	CP5
Oct	487	9 (2%)	18 (4%)	25 (5%)	19 (4%)	479	9 (2%)	13 (3%)	20 (4%)	13 (3%)
Nov	447	15 (3%)	25 (6%)	32 (7%)	27 (6%)	441	16 (4%)	20 (5%)	28 (6%)	22 (5%)
Dec	459	8 (2%)	14 (3%)	18 (4%)	14 (3%)	453	9 (2%)	11 (2%)	16 (3%)	11 (3%)
Jan	475	6 (1%)	10 (2%)	14 (3%)	10 (2%)	473	6 (1%)	6 (1%)	12 (2%)	8 (2%)
Feb	492	3 (1%)	6 (1%)	8 (2%)	6 (1%)	494	3 (1%)	2 (0%)	7 (1%)	4 (1%)
Mar	594	3 (0%)	5 (1%)	7 (1%)	5 (1%)	599	3 (1%)	2 (0%)	5 (1%)	3 (0%)
Apr	723	2 (0%)	4 (1%)	6 (1%)	4 (1%)	725	3 (0%)	1 (0%)	5 (1%)	2 (0%)
May	844	2 (0%)	4 (0%)	6 (1%)	4 (0%)	846	4 (0%)	2 (0%)	5 (1%)	3 (0%)
Jun	820	1 (0%)	3 (0%)	9 (1%)	3 (0%)	814	4 (1%)	3 (0%)	10 (1%)	5 (1%)
Jul	681	5 (1%)	6 (1%)	12 (2%)	6 (1%)	669	5 (1%)	8 (1%)	12 (2%)	8 (1%)
Aug	608	4 (1%)	7 (1%)	14 (2%)	7 (1%)	597	4 (1%)	6 (1%)	10 (2%)	5 (1%)
Sep	509	7 (1%)	13 (3%)	19 (4%)	14 (3%)	505	7 (1%)	11 (2%)	18 (3%)	12 (2%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node S8)
Note:
Simulation period: 1922-2003
(%) indicates percent change from either existing condition or No-Action Alternative
Key:
Alt = alternative
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre-feet

Table 6-19. Simulated Monthly Average American River Flow near the H Street Bridge

Month	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition (cfs)	Change from Base (cfs)				No-Action Alt (cfs)	Change from Base (cfs)			
		CP1 and CP4	CP2 and CP4A	CP3	CP5		CP1 and CP4	CP2 and CP4A	CP3	CP5
Oct	1,522	-32 (-2%)	-93 (-6%)	-88 (-6%)	-81 (-5%)	1,347	-43 (-3%)	-29 (-2%)	-53 (-4%)	-34 (-3%)
Nov	2,670	-101 (-4%)	-107 (-4%)	-117 (-4%)	-123 (-5%)	2,482	-104 (-4%)	-118 (-5%)	-125 (-5%)	-143 (-6%)
Dec	3,272	109 (3%)	174 (5%)	224 (7%)	198 (6%)	3,102	116 (4%)	151 (5%)	192 (6%)	170 (5%)
Jan	4,364	43 (1%)	64 (1%)	66 (2%)	66 (2%)	4,175	46 (1%)	65 (2%)	66 (2%)	58 (1%)
Feb	5,113	45 (1%)	77 (2%)	93 (2%)	70 (1%)	4,869	46 (1%)	70 (1%)	84 (2%)	70 (1%)
Mar	3,696	6 (0%)	11 (0%)	18 (0%)	15 (0%)	3,496	-1 (0%)	8 (0%)	19 (1%)	9 (0%)
Apr	3,155	17 (1%)	15 (0%)	20 (1%)	19 (1%)	2,813	0 (0%)	5 (0%)	5 (0%)	5 (0%)
May	3,429	2 (0%)	0 (0%)	9 (0%)	10 (0%)	2,982	-11 (0%)	-13 (0%)	-8 (0%)	-17 (-1%)
Jun	3,413	8 (0%)	19 (1%)	-59 (-2%)	11 (0%)	2,955	-12 (0%)	-19 (-1%)	-101 (-3%)	-29 (-1%)
Jul	3,593	-55 (-2%)	-52 (-1%)	-50 (-1%)	-49 (-1%)	3,070	-9 (0%)	-73 (-2%)	-33 (-1%)	-67 (-2%)
Aug	2,321	12 (1%)	-19 (-1%)	-40 (-2%)	-18 (-1%)	1,754	29 (2%)	17 (1%)	15 (1%)	51 (3%)
Sep	2,898	-57 (-2%)	-97 (-3%)	-98 (-3%)	-133 (-5%)	2,378	-56 (-2%)	-96 (-4%)	-129 (-5%)	-128 (-5%)
Total (TAF)	2,371	0 (0%)	-1 (0%)	-1 (0%)	-1 (0%)	2,128	0 (0%)	-2 (0%)	-4 (0%)	-3 (0%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node C302)

Notes:
Simulation period: 1922-2003
(%) indicates percent change from either existing condition or No-Action Alternative

Key:
Alt = alternative
cfs = cubic feet per second
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre-feet

The Delta is the confluence of the Sacramento, San Joaquin, Cosumnes, Calaveras, and Mokelumne rivers in addition to several other smaller streams and creeks. As the “central hub” of California’s water supplies, minor changes in operations in one region could result in other minor changes throughout the system. As previously described, changes in operations associated with the SLWRI alternatives could possibly result in minor changes in operations to other CVP and SWP facilities. New Melones Reservoir on the Stanislaus River is operated by the CVP to meet water quality requirements in the lower San Joaquin River only, not in the South Delta, and would not be expected to be affected by changes in Sacramento River flow or Delta exports. Simulations indicate the SLWRI alternatives would not result in any changes to New Melones operations. (See Attachment 1 of the Modeling Appendix for details about New Melones Reservoir and Stanislaus River operations.)

Besides potentially changing exports to south-of-Delta water users, changes in Delta inflow could also be reflected in changes in Delta outflow. Changes in Sacramento River flow, as shown above in Table 6-15, are typically reflected as a combination of Delta outflow and export. Table 6-20 shows changes in Delta outflow associated with each alternative.

Table 6-20. Simulated Monthly Average Change in Delta Outflow

Month	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition (cfs)	Change from Base (cfs)				No-Action Alt (cfs)	Change from Base (cfs)			
		CP1 and CP4	CP2 and CP4A	CP3	CP5		CP1 and CP4	CP2 and CP4A	CP3	CP5
Oct	6,067	-4 (0%)	14 (0%)	-11 (0%)	5 (0%)	6,000	2 (0%)	0 (0%)	-19 (0%)	3 (0%)
Nov	11,706	-157 (-1%)	-157 (-1%)	-165 (-1%)	-175 (-1%)	11,675	-150 (-1%)	-174 (-1%)	-191 (-2%)	-209 (-2%)
Dec	21,755	-153 (-1%)	-134 (-1%)	-327 (-2%)	-318 (-1%)	21,745	-152 (-1%)	-274 (-1%)	-359 (-2%)	-421 (-2%)
Jan	42,078	-77 (0%)	-218 (-1%)	-296 (-1%)	-262 (-1%)	42,169	-198 (0%)	-277 (-1%)	-400 (-1%)	-363 (-1%)
Feb	51,618	-92 (0%)	-160 (0%)	-187 (0%)	-278 (-1%)	51,430	-156 (0%)	-235 (0%)	-303 (-1%)	-396 (-1%)
Mar	42,722	-71 (0%)	-142 (0%)	-146 (0%)	-191 (0%)	42,585	-3 (0%)	-55 (0%)	-157 (0%)	-116 (0%)
Apr	30,227	9 (0%)	12 (0%)	73 (0%)	55 (0%)	30,743	13 (0%)	39 (0%)	83 (0%)	51 (0%)
May	22,619	-52 (0%)	-80 (0%)	-67 (0%)	-71 (0%)	22,249	-53 (0%)	-79 (0%)	-40 (0%)	-70 (0%)
Jun	12,829	-52 (0%)	-69 (-1%)	-49 (0%)	-73 (-1%)	12,660	-41 (0%)	-65 (-1%)	-78 (-1%)	-110 (-1%)
Jul	7,864	0 (0%)	5 (0%)	13 (0%)	0 (0%)	7,864	5 (0%)	-3 (0%)	-1 (0%)	-9 (0%)
Aug	4,322	16 (0%)	21 (0%)	-6 (0%)	13 (0%)	4,335	14 (0%)	22 (1%)	-7 (0%)	19 (0%)
Sep	9,841	-2 (0%)	4 (0%)	-5 (0%)	25 (0%)	9,844	14 (0%)	38 (0%)	20 (0%)	53 (1%)
Total (TAF)	15,776	-38 (0%)	-54 (0%)	-71 (0%)	-76 (0%)	15,755	-42 (0%)	-64 (0%)	-87 (-1%)	-94 (-1%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node C406)

Notes:

Simulation period: 1922-2003

(%) indicates percent change from either existing condition or No-Action Alternative

Key:

Alt = alternative

cfs = cubic feet per second

CP = comprehensive plan

SLWRI = Shasta Lake Water Resources Investigation

TAF = thousand acre-feet

The CVP and SWP divert water via the Jones Pumping Plant and the Banks Pumping Plant, respectively. The increase in water supply from the SLWRI alternatives would typically be moved through the Jones Pumping Plant. However, even under existing conditions or No-Action Alternative (the bases of comparison), pumping capacity at Jones is often already maximized in wetter years, leaving little ability to export any additional water due to physical pumping limits or regulatory pumping restrictions. Accordingly, although unmet CVP demand south of the Delta may exist in some relatively wet years, conveyance restrictions could limit opportunities to export available water south of the Delta in those years. In drier years, however, capacity is typically available to increase pumping at Jones Pumping Plant, and with the increase in Shasta storage there is an increase in water supply available for pumping. Thus, there are greater increases in average annual pumping volumes in drier years.

Tables 6-21 and 6-22 show the average annual exports through Jones Pumping Plant in all years and dry and critical years only, respectively.

Table 6-21. Simulated Monthly Average Exports Through Jones Pumping Plant

Month	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition (cfs)	Change from Base (cfs)				No-Action Alt (cfs)	Change from Base (cfs)			
		CP1 and CP4	CP2 and CP4A	CP3	CP5		CP1 and CP4	CP2 and CP4A	CP3	CP5
Oct	3,662	-2 (0%)	-33 (-1%)	50 (1%)	-34 (-1%)	3,566	-14 (0%)	-3 (0%)	71 (2%)	-27 (-1%)
Nov	3,793	111 (3%)	139 (4%)	146 (4%)	129 (3%)	3,670	111 (3%)	170 (5%)	213 (6%)	184 (5%)
Dec	4,008	1 (0%)	-11 (0%)	12 (0%)	-7 (0%)	3,957	4 (0%)	15 (0%)	-2 (0%)	37 (1%)
Jan	3,207	11 (0%)	57 (2%)	28 (1%)	48 (1%)	3,154	18 (1%)	5 (0%)	36 (1%)	16 (1%)
Feb	3,229	-38 (-1%)	-7 (0%)	-15 (0%)	14 (0%)	3,127	9 (0%)	14 (0%)	31 (1%)	52 (2%)
Mar	2,953	17 (1%)	37 (1%)	-9 (0%)	22 (1%)	2,967	-42 (-1%)	-33 (-1%)	-24 (-1%)	-26 (-1%)
Apr	1,082	0 (0%)	0 (0%)	2 (0%)	2 (0%)	1,179	1 (0%)	1 (0%)	2 (0%)	3 (0%)
May	1,114	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1,102	1 (0%)	1 (0%)	2 (0%)	1 (0%)
Jun	2,431	-5 (0%)	11 (0%)	10 (0%)	-1 (0%)	2,453	11 (0%)	3 (0%)	-13 (-1%)	-3 (0%)
Jul	4,011	7 (0%)	10 (0%)	28 (1%)	35 (1%)	3,925	-18 (0%)	-36 (-1%)	7 (0%)	-18 (0%)
Aug	4,044	-66 (-2%)	-148 (-4%)	18 (0%)	-171 (-4%)	3,897	6 (0%)	-15 (0%)	162 (4%)	-8 (0%)
Sep	3,904	32 (1%)	15 (0%)	70 (2%)	110 (3%)	3,888	49 (1%)	65 (2%)	101 (3%)	123 (3%)
Total (TAF)	2,261	4 (0%)	4 (0%)	21 (1%)	8 (0%)	2,227	8 (0%)	11 (0%)	35 (2%)	20 (1%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node D418)

Notes:
Simulation period: 1922-2003
(%) indicates percent change from either existing condition or No-Action Alternative
Key:
Alt = alternative
cfs = cubic feet per second
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre-feet

Table 6-22. Simulated Monthly Average Exports Through Jones Pumping Plant in Dry and Critical Years

Month	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition (cfs)	Change from Base (cfs)				No-Action Alt (cfs)	Change from Base (cfs)			
		CP1 and CP4	CP2 and CP4A	CP3	CP5		CP1 and CP4	CP2 and CP4A	CP3	CP5
Oct	3,591	4 (0%)	-59 (-2%)	78 (2%)	-65 (-2%)	3,448	-18 (-1%)	11 (0%)	109 (3%)	0 (0%)
Nov	3,509	105 (3%)	145 (4%)	140 (4%)	145 (4%)	3,396	157 (5%)	237 (7%)	279 (8%)	234 (7%)
Dec	3,939	14 (0%)	-57 (-1%)	4 (0%)	-41 (-1%)	3,765	-1 (0%)	23 (1%)	-23 (-1%)	67 (2%)
Jan	3,058	31 (1%)	140 (5%)	41 (1%)	120 (4%)	2,946	29 (1%)	30 (1%)	37 (1%)	18 (1%)
Feb	2,757	-10 (0%)	55 (2%)	-5 (0%)	85 (3%)	2,602	50 (2%)	93 (4%)	70 (3%)	159 (6%)
Mar	1,956	30 (2%)	84 (4%)	-19 (-1%)	44 (2%)	1,921	-36 (-2%)	-3 (0%)	-10 (-1%)	0 (0%)
Apr	931	0 (0%)	0 (0%)	0 (0%)	0 (0%)	963	1 (0%)	11 (1%)	11 (1%)	11 (1%)
May	857	1 (0%)	-1 (0%)	0 (0%)	0 (0%)	850	2 (0%)	4 (0%)	5 (1%)	4 (0%)
Jun	1,139	-15 (-1%)	-18 (-2%)	-8 (-1%)	-25 (-2%)	1,102	-15 (-1%)	-45 (-4%)	-27 (-2%)	-23 (-2%)
Jul	3,379	14 (0%)	21 (1%)	27 (1%)	67 (2%)	3,180	-26 (-1%)	-60 (-2%)	23 (1%)	-19 (-1%)
Aug	3,402	-173 (-5%)	-353 (-10%)	87 (3%)	-433 (-13%)	2,996	45 (2%)	-4 (0%)	438 (15%)	17 (1%)
Sep	3,358	78 (2%)	42 (1%)	79 (2%)	215 (6%)	3,253	81 (3%)	133 (4%)	127 (4%)	198 (6%)
Total (TAF)	1,926	5 (0%)	-1 (0%)	26 (1%)	6 (0%)	1,838	16 (1%)	25 (1%)	63 (3%)	39 (2%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node D418)

Notes:
Simulation period: 1922-2003
Dry and critical years as defined by the Sacramento Valley Index
(%) indicates percent change from either existing condition or No-Action Alternative
Key:
Alt = alternative
cfs = cubic feet per second
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre-feet

Recipients of exports through the Jones Pumping Plant include San Joaquin Valley Exchange Contractors, Federal wildlife refuges, and water service contractors. Because the Exchange Contractors have substantially higher levels of reliability of delivery compared to the refuges and water service contractors, their deliveries will not change under any of the SLWRI alternatives. Deliveries to the refuges and water service contractors would increase with an enlargement of Shasta Dam.

Tables 6-23 and 6-24 show the mean monthly delivery to the CVP south-of-Delta refuges and water service contractors for all years and for dry and critical years respectively. Differences in timing between exports through the Jones and Banks pumping plants and deliveries to CVP and SWP contractors are because of the ability of both projects to store water in San Luis Reservoir during winter months and to use that storage to augment Delta exports in summer months. (Attachment 1 of the Modeling Appendix includes information about San Luis Reservoir storage.)

Table 6-23. Simulated Monthly Average Deliveries to South-of-Delta CVP Water Service Contractors and Refuges

Month	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition	Change from Base				No-Action Alt	Change from Base			
		CP1 and CP4	CP2 and CP4A	CP3	CP5		CP1 and CP4	CP2 and CP4A	CP3	CP5
South-of-Delta CVP Water Service Contractors Deliveries (cfs)										
Oct	474	3 (1%)	4 (1%)	10 (2%)	6 (1%)	464	6 (1%)	8 (2%)	19 (4%)	13 (3%)
Nov	362	3 (1%)	3 (1%)	8 (2%)	4 (1%)	354	4 (1%)	6 (2%)	15 (4%)	10 (3%)
Dec	501	3 (1%)	4 (1%)	10 (2%)	6 (1%)	490	6 (1%)	8 (2%)	20 (4%)	13 (3%)
Jan	880	6 (1%)	7 (1%)	18 (2%)	11 (1%)	860	10 (1%)	14 (2%)	35 (4%)	23 (3%)
Feb	1,100	8 (1%)	9 (1%)	23 (2%)	13 (1%)	1,076	13 (1%)	18 (2%)	44 (4%)	29 (3%)
Mar	660	13 (2%)	15 (2%)	35 (5%)	22 (3%)	634	15 (2%)	20 (3%)	49 (8%)	35 (5%)
Apr	1,079	11 (1%)	13 (1%)	31 (3%)	20 (2%)	1,052	15 (1%)	23 (2%)	54 (5%)	38 (4%)
May	1,564	11 (1%)	12 (1%)	32 (2%)	18 (1%)	1,528	19 (1%)	25 (2%)	63 (4%)	41 (3%)
Jun	2,596	28 (1%)	30 (1%)	64 (2%)	37 (1%)	2,545	32 (1%)	42 (2%)	106 (4%)	69 (3%)
Jul	3,136	20 (1%)	23 (1%)	65 (2%)	34 (1%)	3,063	37 (1%)	39 (1%)	114 (4%)	71 (2%)
Aug	2,078	1 (0%)	16 (1%)	62 (3%)	19 (1%)	2,063	9 (0%)	23 (1%)	89 (4%)	40 (2%)
Sep	735	0 (0%)	0 (0%)	9 (1%)	5 (1%)	722	10 (1%)	15 (2%)	30 (4%)	22 (3%)
Total (TAF)	916	6 (1%)	8 (1%)	22 (2%)	12 (1%)	898	11 (1%)	15 (2%)	39 (4%)	24 (3%)
South-of-Delta Refuges Deliveries (cfs)										
Oct	1,126	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1,041	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Nov	729	0 (0%)	0 (0%)	0 (0%)	0 (0%)	671	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Dec	336	0 (0%)	0 (0%)	0 (0%)	0 (0%)	306	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Jan	147	0 (0%)	0 (0%)	0 (0%)	0 (0%)	137	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Feb	109	0 (0%)	0 (0%)	0 (0%)	0 (0%)	102	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Mar	93	0 (0%)	0 (0%)	0 (0%)	0 (0%)	88	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Apr	217	0 (0%)	0 (0%)	0 (0%)	0 (0%)	203	0 (0%)	0 (0%)	0 (0%)	0 (0%)
May	445	0 (0%)	0 (0%)	0 (0%)	0 (0%)	407	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Jun	493	0 (0%)	0 (0%)	0 (0%)	0 (0%)	456	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Jul	120	0 (0%)	0 (0%)	0 (0%)	0 (0%)	112	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Aug	197	2 (1%)	0 (0%)	2 (1%)	1 (0%)	181	2 (1%)	2 (1%)	5 (3%)	3 (2%)
Sep	885	-9 (-1%)	-8 (-1%)	-11 (-1%)	-7 (-1%)	808	0 (0%)	5 (1%)	1 (0%)	5 (1%)
Total (TAF)	296	0 (0%)	0 (0%)	-1 (0%)	0 (0%)	273	0 (0%)	0 (0%)	0 (0%)	0 (0%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Nodes DEL_CVP_PAG_S and DEL_CVP_PRF_S)

Notes: Simulation period: 1922-2003
Dry and critical years as defined by the Sacramento Valley Index
(%) indicates percent change from either existing condition or No-Action Alternative
Key:
Alt = alternative
cfs = cubic feet per second
CP = comprehensive plan
CVP = Central Valley Project
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre-feet

Table 6-24. Simulated Monthly Average Deliveries to South-of-Delta CVP Water Service Contractors and Refuges in Dry and Critical Years

Month	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition	Change from Base				No-Action Alt	Change from Base			
		CP1 and CP4	CP2 and CP4A	CP3	CP5		CP1 and CP4	CP2 and CP4A	CP3	CP5
South-of-Delta CVP Water Service Contractors Deliveries (cfs)										
Oct	363	6 (2%)	4 (1%)	15 (4%)	11 (3%)	343	8 (2%)	12 (3%)	27 (8%)	21 (6%)
Nov	277	4 (2%)	3 (1%)	12 (4%)	8 (3%)	262	6 (2%)	9 (3%)	21 (8%)	16 (6%)
Dec	383	6 (2%)	4 (1%)	16 (4%)	11 (3%)	362	8 (2%)	12 (3%)	29 (8%)	23 (6%)
Jan	673	10 (2%)	8 (1%)	29 (4%)	20 (3%)	636	14 (2%)	22 (3%)	51 (8%)	40 (6%)
Feb	841	13 (2%)	10 (1%)	36 (4%)	25 (3%)	794	18 (2%)	27 (3%)	63 (8%)	50 (6%)
Mar	362	15 (4%)	9 (2%)	26 (7%)	17 (5%)	302	6 (2%)	12 (4%)	53 (18%)	37 (12%)
Apr	627	-1 (0%)	-10 (-2%)	2 (0%)	-9 (-1%)	545	5 (1%)	11 (2%)	51 (9%)	34 (6%)
May	902	-2 (0%)	-14 (-2%)	2 (0%)	-11 (-1%)	794	11 (1%)	19 (2%)	72 (9%)	45 (6%)
Jun	1,467	23 (2%)	4 (0%)	30 (2%)	0 (0%)	1,310	19 (1%)	32 (2%)	122 (9%)	76 (6%)
Jul	1,809	-10 (-1%)	-34 (-2%)	0 (0%)	-30 (-2%)	1,581	19 (1%)	5 (0%)	109 (7%)	58 (4%)
Aug	1,112	-40 (-4%)	-22 (-2%)	48 (4%)	-34 (-3%)	939	31 (3%)	59 (6%)	163 (17%)	73 (8%)
Sep	428	-8 (-2%)	-12 (-3%)	-5 (-1%)	-6 (-1%)	370	7 (2%)	16 (4%)	35 (10%)	27 (7%)
Total (TAF)	558	1 (0%)	-3 (-1%)	13 (2%)	0 (0%)	497	9 (2%)	14 (3%)	48 (10%)	30 (6%)
South-of-Delta Refuges Deliveries (cfs)										
Oct	1,110	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1,026	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Nov	718	0 (0%)	0 (0%)	0 (0%)	0 (0%)	661	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Dec	331	0 (0%)	0 (0%)	0 (0%)	0 (0%)	302	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Jan	145	0 (0%)	0 (0%)	0 (0%)	0 (0%)	135	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Feb	107	0 (0%)	0 (0%)	0 (0%)	0 (0%)	101	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Mar	89	0 (0%)	0 (0%)	0 (0%)	0 (0%)	83	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Apr	207	0 (0%)	0 (0%)	0 (0%)	0 (0%)	193	0 (0%)	0 (0%)	0 (0%)	0 (0%)
May	423	0 (0%)	0 (0%)	0 (0%)	0 (0%)	387	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Jun	468	1 (0%)	1 (0%)	1 (0%)	0 (0%)	434	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Jul	114	0 (0%)	0 (0%)	0 (0%)	0 (0%)	107	0 (0%)	-1 (-1%)	0 (0%)	-1 (-1%)
Aug	185	1 (1%)	-5 (-3%)	3 (1%)	1 (1%)	161	7 (4%)	4 (3%)	13 (8%)	9 (5%)
Sep	843	-6 (-1%)	-3 (0%)	-11 (-1%)	0 (0%)	760	0 (0%)	14 (2%)	2 (0%)	13 (2%)
Total (TAF)	286	0 (0%)	0 (0%)	0 (0%)	0 (0%)	263	0 (0%)	1 (0%)	1 (0%)	1 (0%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Nodes DEL_CVP_PAG_S and DEL_CVP_PRF_S)

Notes: Simulation period: 1922-2003
Dry and critical years as defined by the Sacramento Valley Index
(%) indicates percent change from either existing condition or No-Action Alternative
Key:
Alt = alternative
cfs = cubic feet per second
CP = comprehensive plan
CVP = Central Valley Project
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre-feet

When evaluating project effects on water supply reliability, CVP south-of-Delta allocations are a valuable indicator of benefits resulting from each alternative. Tables 6-25 and 6-26 show the simulated annual allocations to south-of-Delta agricultural and M&I refuges and water service contractors for the existing condition and the No-Action Alternative, and the simulated change in allocation for each of the SLWRI alternatives. Simulated allocations are calculated by dividing annual deliveries of each contract type by the demand. The contract period for CVP allocations is assumed to be March through February; the assumed simulated demand for each contract type is as follows:

- **Agricultural water service contractors –** 1.987 MAF/year (both 2005 and 2030 level of development)
- **M&I water service contractors –** 164,200 acre-feet/year (both 2005 and 2030 level of development)
- **Federal refuges –** 304,600 acre-feet/year (2005 level of development) and 281,100 acre-feet/year (2030 level of development)

Tables 6-25 and 6-26 show that changes in allocations would typically increase, and years with small decreases in allocations could occur. More important than the average annual change in allocation is the increase in allocation in years with low allocations under either the existing condition or No-Action Alternative, such as in 1928, 1944, and 1976. Some decreases in allocations would occur during years in the latter parts of prolonged droughts. This likely is because of changes in CalSim-II north-of-Delta reservoir storage and water supply relationships.

Table 6-25. Simulated Annual Delivery Allocations to South-of-Delta CVP Water Service Contractors and Refuges for a 2005 Level of Development

Year	Existing Conditions (2005)			Change from Existing Conditions											
				CP1 and CP4 (2005)			CP2 and CP4A (2005)			CP3 (2005)			CP5 (2005)		
	Ag	Ref	M&I	Ag	Ref	M&I	Ag	Ref	M&I	Ag	Ref	M&I	Ag	Ref	M&I
1922	79%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1923	42%	100%	67%	0%	0%	0%	0%	0%	0%	-1%	0%	0%	0%	0%	0%
1924	16%	75%	61%	-2%	0%	-2%	-2%	0%	-2%	-2%	0%	-2%	-5%	0%	-5%
1925	38%	100%	67%	-2%	0%	0%	-2%	0%	0%	-2%	0%	0%	2%	0%	0%
1926	20%	100%	64%	2%	0%	2%	-2%	0%	-2%	-3%	0%	-3%	-7%	0%	-7%
1927	48%	100%	69%	-1%	0%	-1%	1%	0%	1%	1%	0%	1%	2%	0%	2%
1928	42%	100%	67%	3%	0%	0%	3%	0%	0%	3%	0%	0%	3%	0%	0%
1929	0%	100%	45%	0%	0%	0%	1%	0%	1%	0%	0%	0%	0%	0%	0%
1930	25%	100%	67%	3%	0%	0%	-4%	0%	-2%	1%	0%	0%	2%	0%	0%
1931	14%	75%	58%	-1%	0%	-1%	0%	0%	0%	1%	0%	1%	0%	0%	0%
1932	22%	75%	67%	-4%	0%	-4%	-4%	0%	-4%	-3%	0%	-2%	-6%	0%	-6%
1933	9%	75%	54%	0%	0%	0%	1%	0%	1%	0%	0%	0%	1%	0%	1%
1934	16%	75%	61%	-1%	0%	-1%	0%	0%	0%	0%	0%	0%	-1%	0%	-1%
1935	24%	100%	64%	-1%	0%	0%	-5%	0%	-1%	-5%	0%	-1%	-5%	0%	-1%
1936	41%	100%	67%	0%	0%	0%	3%	0%	0%	6%	0%	1%	1%	0%	0%
1937	31%	100%	66%	-1%	0%	0%	1%	0%	0%	2%	0%	0%	0%	0%	0%
1938	92%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1939	35%	98%	66%	0%	2%	-4%	0%	2%	-6%	-1%	0%	-6%	-1%	2%	-6%
1940	35%	100%	67%	1%	0%	0%	2%	0%	0%	3%	0%	0%	2%	0%	0%
1941	73%	100%	88%	1%	0%	0%	1%	0%	0%	1%	0%	0%	1%	0%	0%
1942	74%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1943	77%	100%	90%	4%	0%	0%	4%	0%	0%	4%	0%	0%	4%	0%	0%
1944	28%	100%	67%	1%	0%	0%	0%	0%	0%	3%	0%	0%	3%	0%	0%
1945	57%	100%	77%	-4%	0%	-3%	-4%	0%	-3%	0%	0%	0%	-4%	0%	-3%
1946	54%	100%	75%	3%	0%	3%	3%	0%	3%	1%	0%	1%	3%	0%	3%
1947	41%	100%	66%	-1%	0%	0%	1%	0%	0%	1%	0%	0%	0%	0%	0%
1948	23%	100%	67%	-2%	0%	-2%	-1%	0%	-1%	7%	0%	0%	3%	0%	0%
1949	53%	100%	75%	0%	0%	0%	0%	0%	0%	-1%	0%	-2%	0%	0%	-1%
1950	34%	100%	67%	3%	0%	0%	2%	0%	0%	5%	0%	0%	5%	0%	0%
1951	57%	100%	78%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1952	92%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1953	36%	100%	67%	2%	0%	0%	2%	0%	0%	2%	0%	0%	2%	0%	0%
1954	36%	100%	65%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1955	43%	100%	66%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1956	73%	100%	88%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1957	25%	100%	67%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1958	89%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1959	29%	100%	67%	-1%	0%	0%	-1%	0%	0%	-1%	0%	0%	-1%	0%	0%
1960	30%	100%	61%	2%	0%	0%	3%	-2%	0%	6%	0%	6%	3%	-2%	0%
1961	36%	100%	61%	-5%	-2%	-1%	-6%	-2%	-1%	-5%	0%	-1%	-6%	0%	-1%
1962	43%	100%	67%	2%	0%	0%	3%	0%	0%	2%	0%	0%	3%	0%	0%
1963	43%	100%	67%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1964	41%	100%	66%	0%	0%	0%	0%	0%	0%	1%	0%	1%	0%	0%	0%
1965	62%	100%	77%	0%	0%	-1%	0%	0%	-1%	0%	0%	0%	-1%	0%	0%
1966	39%	100%	67%	1%	0%	0%	1%	0%	0%	1%	0%	0%	1%	0%	0%
1967	92%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1968	32%	100%	67%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1969	92%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table 6-25. Simulated Annual Delivery Allocations to South-of-Delta CVP Water Service Contractors and Refuges for a 2005 Level of Development (contd.)

Year	Existing Conditions (2005)			Change from Existing Conditions											
				CP1 and CP4 (2005)			CP2 and CP4A (2005)			CP3 (2005)			CP5 (2005)		
	Ag	Ref	M&I	Ag	Ref	M&I	Ag	Ref	M&I	Ag	Ref	M&I	Ag	Ref	M&I
1970	57%	100%	77%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1971	32%	100%	67%	2%	0%	0%	5%	0%	0%	7%	0%	0%	7%	0%	0%
1972	37%	100%	67%	0%	0%	0%	-1%	0%	0%	-1%	0%	0%	-1%	0%	0%
1973	50%	100%	71%	4%	0%	3%	4%	0%	3%	4%	0%	3%	4%	0%	3%
1974	76%	100%	88%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1975	54%	100%	75%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1976	15%	100%	60%	4%	0%	3%	2%	0%	2%	7%	0%	7%	6%	0%	6%
1977	11%	75%	56%	0%	0%	0%	1%	0%	1%	1%	0%	1%	2%	0%	2%
1978	83%	100%	89%	4%	0%	0%	7%	0%	0%	8%	0%	1%	2%	0%	0%
1979	51%	100%	72%	-1%	0%	-1%	-2%	0%	-1%	-2%	0%	-1%	0%	0%	0%
1980	81%	99%	88%	4%	-11%	-10%	4%	-11%	-10%	4%	-11%	-10%	4%	-11%	-10%
1981	32%	100%	67%	-1%	0%	0%	-1%	0%	0%	-1%	0%	0%	-1%	0%	0%
1982	92%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1983	92%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1984	58%	100%	78%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1985	43%	100%	67%	2%	0%	-1%	2%	0%	-1%	2%	0%	0%	2%	0%	-6%
1986	63%	100%	83%	2%	0%	2%	6%	0%	6%	21%	0%	7%	16%	0%	7%
1987	25%	100%	66%	2%	0%	0%	1%	0%	0%	0%	0%	0%	1%	0%	0%
1988	0%	100%	45%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1989	28%	99%	58%	0%	1%	3%	-1%	-1%	7%	0%	1%	6%	-2%	1%	6%
1990	0%	100%	45%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1991	20%	75%	64%	-1%	0%	-1%	-1%	-2%	-11%	0%	0%	0%	-1%	0%	-12%
1992	22%	74%	61%	-2%	-3%	-7%	0%	0%	1%	0%	-6%	-6%	-1%	1%	5%
1993	50%	100%	73%	2%	0%	2%	1%	0%	1%	1%	0%	1%	0%	0%	-1%
1994	49%	75%	64%	-2%	0%	0%	-2%	0%	0%	0%	0%	0%	-3%	0%	0%
1995	88%	100%	90%	2%	0%	0%	3%	0%	0%	4%	0%	0%	4%	0%	0%
1996	62%	100%	83%	0%	0%	0%	-1%	0%	-1%	-1%	0%	-1%	-1%	0%	-1%
1997	66%	98%	81%	0%	2%	-2%	1%	2%	7%	1%	2%	7%	1%	0%	9%
1998	92%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1999	48%	100%	70%	3%	0%	2%	5%	0%	4%	6%	0%	6%	6%	0%	6%
2000	48%	100%	69%	0%	0%	0%	-1%	0%	-1%	-1%	0%	-1%	-1%	0%	-1%
2001	38%	100%	67%	2%	0%	0%	2%	0%	0%	2%	0%	0%	2%	0%	0%
2002	32%	100%	67%	-1%	0%	0%	1%	0%	0%	2%	0%	0%	0%	0%	0%
2003	36%	50%	43%	0%	0%	0%	-1%	0%	0%	-1%	0%	0%	-2%	0%	0%
Avg	**46%**	**97%**	**71%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**1%**	**0%**	**0%**	**1%**	**0%**	**0%**

Source: SLWRI 2012 Version CalSim-II model 2005 simulations (Nodes DEL_CVP_PAG_S, DEL_CVP_PRF_S, and DEL_CVP_PMI_S for delivery information, and Common Assumptions Common Model Package Version 8D Delivery Specifications for demand information)

Notes:

Simulation period: 1922-2003

(%) indicates change from either existing condition or No-Action Alternative

Key:

Ag = Agricultural Water Service Contractor

Alt = alternative

Avg = average

M&I = municipal and industrial contractor

Ref = refuge

Refuge = Level 2 Federal Refuge

SLWRI = Shasta Lake Water Resources Investigation

Table 6-26. Simulated Annual Delivery Allocations to South-of-Delta CVP Water Service Contractors and Refuges for a 2030 Level of Development

Year	No-Action/ No Project Alternative (2030)			Change from No-Action/ No Project Alternative											
				CP1 and CP4 (2030)			CP2 and CP4A (2030)			CP3 (2030)			CP5 (2030)		
	Ag	Ref	M&I	Ag	Ref	M&I	Ag	Ref	M&I	Ag	Ref	M&I	Ag	Ref	M&I
1922	80%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1923	41%	100%	67%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1924	8%	75%	53%	0%	0%	0%	-1%	0%	-1%	2%	0%	2%	-1%	0%	-1%
1925	46%	100%	68%	0%	0%	0%	-2%	0%	-1%	-2%	0%	-1%	-2%	0%	-1%
1926	17%	100%	61%	-4%	0%	-4%	-8%	0%	-8%	-7%	0%	-7%	-9%	0%	-10%
1927	50%	100%	71%	1%	0%	1%	2%	0%	2%	2%	0%	2%	-1%	0%	-1%
1928	38%	100%	67%	5%	0%	0%	6%	0%	0%	10%	0%	2%	11%	0%	3%
1929	0%	100%	45%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1930	16%	100%	60%	-3%	0%	-3%	-2%	0%	-2%	0%	0%	0%	2%	0%	1%
1931	9%	75%	53%	1%	0%	1%	0%	0%	0%	3%	0%	3%	0%	0%	0%
1932	15%	75%	59%	0%	0%	0%	0%	0%	0%	4%	0%	4%	-1%	0%	-1%
1933	4%	75%	49%	0%	0%	0%	0%	0%	0%	1%	0%	1%	0%	0%	0%
1934	9%	75%	54%	1%	0%	1%	-1%	0%	-1%	2%	0%	2%	1%	0%	1%
1935	21%	100%	63%	-4%	0%	-4%	-7%	0%	-6%	-6%	0%	-5%	-5%	0%	-4%
1936	36%	100%	67%	4%	0%	0%	1%	0%	0%	5%	0%	0%	1%	0%	0%
1937	30%	100%	66%	-2%	0%	0%	-3%	0%	-1%	-2%	0%	-1%	0%	0%	0%
1938	92%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1939	30%	98%	61%	2%	0%	0%	4%	0%	-1%	3%	0%	-1%	4%	0%	-1%
1940	42%	100%	67%	-3%	0%	0%	-3%	0%	0%	0%	0%	0%	-3%	0%	0%
1941	72%	100%	89%	4%	0%	0%	4%	0%	1%	4%	0%	1%	4%	0%	1%
1942	78%	100%	88%	-1%	0%	2%	-1%	0%	2%	-1%	0%	2%	-1%	0%	2%
1943	72%	100%	90%	7%	0%	0%	9%	0%	-2%	9%	0%	-2%	9%	0%	-2%
1944	23%	100%	67%	-3%	0%	-3%	-1%	0%	-1%	4%	0%	0%	3%	0%	0%
1945	57%	100%	78%	-5%	0%	-4%	-6%	0%	-5%	-1%	0%	-1%	-8%	0%	-7%
1946	57%	100%	78%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1947	37%	100%	67%	6%	0%	0%	8%	0%	0%	9%	0%	1%	9%	0%	1%
1948	27%	100%	66%	-5%	0%	0%	-6%	0%	-1%	0%	0%	0%	-4%	0%	0%
1949	52%	100%	74%	1%	0%	1%	1%	0%	1%	0%	0%	-1%	1%	0%	0%
1950	27%	100%	67%	1%	0%	0%	1%	0%	0%	11%	0%	0%	3%	0%	0%
1951	58%	100%	79%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1952	92%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1953	39%	100%	67%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1954	39%	100%	66%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1955	33%	100%	67%	6%	0%	0%	10%	0%	0%	12%	0%	-1%	12%	0%	-1%
1956	75%	100%	88%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1957	28%	100%	67%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1958	91%	100%	90%	-1%	0%	0%	-1%	0%	0%	-1%	0%	0%	-1%	0%	0%
1959	31%	100%	67%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1960	25%	98%	60%	3%	0%	0%	4%	0%	0%	9%	2%	-1%	7%	0%	-1%
1961	36%	98%	60%	-2%	1%	0%	-2%	1%	0%	-6%	2%	0%	-3%	2%	0%
1962	42%	100%	67%	2%	0%	0%	2%	0%	0%	3%	0%	0%	3%	0%	0%
1963	45%	100%	67%	0%	0%	0%	0%	0%	0%	-1%	0%	0%	0%	0%	0%
1964	37%	100%	67%	3%	0%	0%	9%	0%	0%	15%	0%	5%	15%	0%	5%
1965	67%	100%	84%	-1%	0%	0%	-1%	0%	0%	-3%	0%	-4%	-2%	0%	0%
1966	38%	100%	67%	-1%	0%	0%	0%	0%	0%	1%	0%	0%	1%	0%	0%
1967	92%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1968	34%	100%	67%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1969	92%	100%	90%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table 6-26. Simulated Annual Delivery Allocations to South-of-Delta CVP Water Service Contractors and Refuges for a 2030 Level of Development (contd.)

Key:
% = percent
Ag = Agricultural Water Service Contractor
Alt = alternative
Avg = average
CP = Comprehensive Plan
CVP = Central Valley Project
M&I = municipal and industrial contractor
Ref = refuge
Refuge = Level 2 Federal Refuge
SLWRI = Shasta Lake Water Resources Investigation

The Banks Pumping Plant provides water supply to SWP contractors, and when capacity is available may also export CVP water to support CVP deliveries. CP1, CP2, CP4, CP4A, and CP5 all include reserving a portion of the increased storage capacity in Shasta Reservoir to specifically focus on increasing M&I deliveries. For this EIS, these operations were simulated in CalSim-II by using the reserved storage capacity to provide deliveries for previously unmet SWP demands during dry and critical years. These additional water supplies for SWP deliveries are pumped through Banks Pumping Plant. Table 6-27 shows average annual exports through Banks Pumping Plant for the various SLWRI alternatives.

Table 6-27. Simulated Monthly Average Exports Through the Banks Pumping Plant

Month	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition (cfs)	Change from Base (cfs)				No-Action Alt (cfs)	Change from Base (cfs)			
		CP1 and CP4	CP2 and CP4A	CP3	CP5		CP1 and CP4	CP2 and CP4A	CP3	CP5
Oct	3,308	46 (1%)	69 (2%)	26 (1%)	92 (3%)	3,156	71 (2%)	87 (3%)	37 (1%)	127 (4%)
Nov	3,155	64 (2%)	89 (3%)	57 (2%)	88 (3%)	3,222	17 (1%)	50 (2%)	43 (1%)	63 (2%)
Dec	4,892	-1 (0%)	7 (0%)	-4 (0%)	12 (0%)	4,949	-1 (0%)	-37 (-1%)	-59 (-1%)	-35 (-1%)
Jan	3,556	-9 (0%)	-48 (-1%)	9 (0%)	-64 (-2%)	3,589	-1 (0%)	9 (0%)	7 (0%)	5 (0%)
Feb	3,960	-2 (0%)	4 (0%)	10 (0%)	-5 (0%)	4,073	0 (0%)	-22 (-1%)	-12 (0%)	-34 (-1%)
Mar	3,936	11 (0%)	-5 (0%)	25 (1%)	14 (0%)	3,958	31 (1%)	21 (1%)	5 (0%)	16 (0%)
Apr	1,065	0 (0%)	1 (0%)	-3 (0%)	-1 (0%)	1,240	0 (0%)	-2 (0%)	-2 (0%)	-6 (0%)
May	1,099	1 (0%)	2 (0%)	-1 (0%)	0 (0%)	1,133	4 (0%)	6 (1%)	-13 (-1%)	6 (1%)
Jun	2,526	3 (0%)	6 (0%)	7 (0%)	17 (1%)	2,550	8 (0%)	14 (1%)	31 (1%)	23 (1%)
Jul	6,435	6 (0%)	15 (0%)	-30 (0%)	26 (0%)	6,274	53 (1%)	109 (2%)	34 (1%)	136 (2%)
Aug	5,597	85 (2%)	141 (3%)	-25 (0%)	169 (3%)	5,603	23 (0%)	57 (1%)	-71 (-1%)	85 (2%)
Sep	5,242	70 (1%)	107 (2%)	-19 (0%)	102 (2%)	5,449	86 (2%)	150 (3%)	2 (0%)	141 (3%)
Total (TAF)	2,706	17 (1%)	23 (1%)	3 (0%)	27 (1%)	2,730	18 (1%)	27 (1%)	0 (0%)	32 (1%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node D419)

Notes:
Simulation period: 1922-2003
(%) indicates percent change from either existing condition or No-Action Alternative

Key:
Alt = alternative
cfs = cubic feet per second
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre-feet

Tables 6-28 and 6-29 show the mean monthly delivery to SWP contractors south of the Delta for all years and for dry and critical years, respectively.

Table 6-28. Simulated Monthly Average Deliveries to SWP Table A Contractors

Month	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition (cfs)	Change from Base (cfs)				No-Action Alt (cfs)	Change from Base (cfs)			
		CP1 and CP4	CP2 and CP4A	CP3	CP5		CP1 and CP4	CP2 and CP4A	CP3	CP5
Oct	3,226	1 (0%)	-7 (0%)	-25 (-1%)	-8 (0%)	3,351	17 (1%)	44 (1%)	-9 (0%)	57 (2%)
Nov	2,689	35 (1%)	51 (2%)	4 (0%)	79 (3%)	2,812	1 (0%)	18 (1%)	1 (0%)	32 (1%)
Dec	2,476	28 (1%)	33 (1%)	4 (0%)	19 (1%)	2,886	28 (1%)	38 (1%)	-1 (0%)	49 (2%)
Jan	623	9 (2%)	18 (3%)	-6 (-1%)	22 (4%)	988	31 (3%)	49 (5%)	-20 (-2%)	55 (6%)
Feb	1,106	21 (2%)	32 (3%)	-6 (-1%)	36 (3%)	1,860	27 (1%)	52 (3%)	-13 (-1%)	59 (3%)
Mar	1,804	18 (1%)	28 (2%)	-6 (0%)	27 (1%)	2,307	14 (1%)	27 (1%)	-9 (0%)	30 (1%)
Apr	4,733	18 (0%)	24 (1%)	1 (0%)	17 (0%)	5,094	27 (1%)	35 (1%)	2 (0%)	40 (1%)
May	5,837	33 (1%)	43 (1%)	17 (0%)	47 (1%)	6,335	23 (0%)	31 (0%)	5 (0%)	36 (1%)
Jun	7,433	-7 (0%)	-22 (0%)	22 (0%)	7 (0%)	7,612	38 (1%)	41 (1%)	-8 (0%)	33 (0%)
Jul	7,841	41 (1%)	49 (1%)	-6 (0%)	55 (1%)	8,147	12 (0%)	31 (0%)	-31 (0%)	27 (0%)
Aug	7,017	14 (0%)	12 (0%)	-25 (0%)	21 (0%)	7,244	-12 (0%)	-13 (0%)	-54 (-1%)	-20 (0%)
Sep	5,086	22 (0%)	47 (1%)	-4 (0%)	54 (1%)	5,322	37 (1%)	52 (1%)	4 (0%)	71 (1%)
Total (TAF)	3,020	14 (0%)	19 (1%)	-2 (0%)	23 (1%)	3,265	15 (0%)	24 (1%)	-8 (0%)	28 (1%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Nodes DEL_SWP_PAG and DEL_SWP_PMI)

Notes:
Simulation period: 1922-2003
(%) indicates percent change from either existing condition or No-Action Alternative
Key:
Alt = alternative
cfs = cubic feet per second
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation
SWP = State Water Project
TAF = thousand acre-feet

Table 6-29. Simulated Monthly Average Deliveries to SWP Table A Contractors in Dry and Critical Years

Month	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition (cfs)	Change from Base (cfs)				No-Action Alt (cfs)	Change from Base (cfs)			
		CP1 and CP4	CP2 and CP4A	CP3	CP5		CP1 and CP4	CP2 and CP4A	CP3	CP5
Oct	2,873	50 (2%)	63 (2%)	8 (0%)	73 (3%)	3,051	32 (1%)	50 (2%)	-13 (0%)	64 (2%)
Nov	2,282	54 (2%)	71 (3%)	6 (0%)	83 (4%)	2,342	2 (0%)	28 (1%)	1 (0%)	33 (1%)
Dec	2,014	82 (4%)	89 (4%)	12 (1%)	76 (4%)	2,392	71 (3%)	78 (3%)	38 (2%)	90 (4%)
Jan	389	-3 (-1%)	0 (0%)	-5 (-1%)	2 (1%)	412	13 (3%)	28 (7%)	-18 (-4%)	32 (8%)
Feb	637	29 (5%)	47 (7%)	-10 (-2%)	48 (8%)	766	21 (3%)	45 (6%)	-25 (-3%)	49 (6%)
Mar	1,041	31 (3%)	56 (5%)	-14 (-1%)	57 (5%)	1,101	30 (3%)	60 (5%)	-31 (-3%)	73 (7%)
Apr	4,156	48 (1%)	69 (2%)	-9 (0%)	47 (1%)	4,251	74 (2%)	102 (2%)	-25 (-1%)	109 (3%)
May	4,983	19 (0%)	55 (1%)	-14 (0%)	60 (1%)	5,143	72 (1%)	103 (2%)	-22 (0%)	118 (2%)
Jun	6,408	-48 (-1%)	-66 (-1%)	-11 (0%)	-24 (0%)	6,471	46 (1%)	61 (1%)	-87 (-1%)	44 (1%)
Jul	6,757	110 (2%)	146 (2%)	-9 (0%)	166 (2%)	6,933	64 (1%)	133 (2%)	-56 (-1%)	126 (2%)
Aug	5,605	45 (1%)	45 (1%)	-58 (-1%)	80 (1%)	5,679	10 (0%)	16 (0%)	-132 (-2%)	2 (0%)
Sep	4,003	62 (2%)	140 (3%)	-8 (0%)	161 (4%)	4,066	119 (3%)	175 (4%)	3 (0%)	225 (6%)
Total (TAF)	2,493	29 (1%)	43 (2%)	-7 (0%)	50 (2%)	2,581	34 (1%)	53 (2%)	-22 (-1%)	58 (2%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Nodes DEL_SWP_PAG and DEL_SWP_PMI)

Notes:
Simulation period: 1922-2003
(%) indicates percent change from either existing condition or No-Action Alternative
Dry and critical years as defined by the Sacramento Valley Index

Key:
Alt = alternative
cfs = cubic feet per second
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation
SWP = State Water Project
TAF = thousand acre-feet

Changes in Delta export operations could potentially result in changes in reservoir operations south of the Delta along the San Joaquin River due to changes in return flows from project deliveries. These changes, if they occur, would be expected to be very small. Any changes in operations of San Joaquin River basin reservoirs would be reflected in changes in San Joaquin River flows near its confluence with the Delta. The San Joaquin River at Vernalis is commonly used as the downstream end of the San Joaquin River. Table 6-30 shows simulated San Joaquin River flow at Vernalis. According to modeling, the SLWRI alternatives do not affect San Joaquin River flows at Vernalis.

Table 6-30. Simulated Monthly Average San Joaquin River Flows at Vernalis

Month	Existing Condition (2005)					Future Condition (2030)				
	Existing Condition (cfs)	Change from Base (cfs)				No-Action Alt (cfs)	Change from Base (cfs)			
		CP1 and CP4	CP2 and CP4A	CP3	CP5		CP1 and CP4	CP2 and CP4A	CP3	CP5
Oct	2,757	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2,753	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Nov	2,633	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2,603	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Dec	3,199	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3,263	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Jan	4,770	0 (0%)	0 (0%)	0 (0%)	0 (0%)	4,764	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Feb	6,265	0 (0%)	0 (0%)	0 (0%)	0 (0%)	6,143	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Mar	7,133	0 (0%)	0 (0%)	0 (0%)	0 (0%)	7,003	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Apr	6,720	0 (0%)	0 (0%)	0 (0%)	0 (0%)	7,533	0 (0%)	0 (0%)	0 (0%)	0 (0%)
May	6,204	0 (0%)	0 (0%)	0 (0%)	0 (0%)	6,234	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Jun	4,739	0 (0%)	0 (0%)	0 (0%)	0 (0%)	4,671	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Jul	3,202	0 (0%)	0 (0%)	1 (0%)	0 (0%)	3,208	0 (0%)	0 (0%)	1 (0%)	1 (0%)
Aug	2,029	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2,040	0 (0%)	0 (0%)	1 (0%)	0 (0%)
Sep	2,331	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2,340	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Total (TAF)	3,126	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3,161	0 (0%)	0 (0%)	0 (0%)	0 (0%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (NodesC639)

Notes:
Simulation period: 1922-2003
(%) indicates percent change from either existing condition or No-Action Alternative
Key:
Alt = alternative
cfs = cubic feet per second
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation
SWP = State Water Project
TAF = thousand acre-feet

No-Action Alternative

For a complete list of the differences between the No-Action Alternative and the existing conditions, see Table 2-1 in the Modeling Appendix.

As described above, modeling indicates that the No-Action Alternative would continue to meet water supply demands at levels of compliance similar to the existing conditions and would not result in any appreciable changes in water supply reliability.

Shasta Lake and Vicinity The significance criteria for H&H do not apply in the Shasta Lake and vicinity geographic region; therefore, potential effects in that geographic region are not discussed further in this EIS.

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact H&H-1 (No-Action): Change in Frequency of Flows above 100,000 cfs on the Sacramento River below Bend Bridge Flood management operations would not change under the No-Action Alternative as compared to the existing condition; the recurrence of flows above 100,000 cfs on the Sacramento River below Bend Bridge would remain the same as the existing condition. No impact would occur. Mitigation is not required for the No-Action Alternative.

Impact H&H-2 (No-Action): Place Housing or Other Structures within a 100-Year Flood Hazard Area as Mapped on a Federal Flood Hazard Boundary or Flood Insurance Rate Map or Other Flood Hazard Delineation Map No new structures would be built in the floodplain under the No-Action Alternative, and flood management operations at Shasta Dam would not change under the No-Action Alternative as compared to the existing condition. No impact would occur. Mitigation is not required for the No-Action Alternative.

Impact H&H-3(No-Action): Place within a 100-Year Flood Hazard Area Structures that Would Impede or Redirect Flood Flows No new structures would be built in the floodplain under the No-Action Alternative, and flood management operations at Shasta Dam would not change under the No-Action Alternative. No impact would occur. Mitigation is not required for the No-Action Alternative.

Lower Sacramento River and Delta

Impact H&H-4 (No-Action): Change in Water Levels in the Old River near Tracy Road Bridge Water levels in the Old River near Tracy Road Bridge could be slightly lower under the No-Action Alternative than the existing condition. This impact would be less than significant.

As shown in Table 6-31, maximum monthly reductions in minimum daily water level associated with No-Action compared to the existing conditions would exceed -0.1 feet; however, the reductions would not result in water levels less than 0.0 feet elevation and would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Table 6-31. Simulated Monthly Maximum 15-Minute Change in Water Levels at Various Locations in the South Delta at Low-Low Tide

Month	Change from Existing Condition		
	Old River near Tracy Road Bridge (feet)	Grant Line Canal near the Grant Line Canal Barrier (feet)	Middle River near the Howard Road Bridge (feet)
Apr	-0.02 (0%)	-0.02 (0%)	-0.02 (0%)
May	-0.27 (0%)	-0.37 (0%)	-0.29 (0%)
Jun	-0.42 (0%)	-0.48 (0%)	-0.45 (0%)
Jul	-0.05 (0%)	-0.04 (0%)	-0.05 (0%)
Aug	-0.05 (0%)	-0.02 (0%)	-0.05 (0%)
Sep	-0.19 (0%)	-0.08 (0%)	-0.21 (0%)
Oct	-0.08 (0%)	-0.03 (0%)	-0.08 (0%)

Source: Version8.0.6 DSM2 2005 and 2030 simulations (Node 071_3116, Node 129_5691, and Node 206_5533)

Notes:
Simulation period: 1922-2003
(%) indicates the percentage of months out of 82 years with a maximum decrease in water level exceeding 0.1 feet.

Impact H&H-5 (No-Action): Change in Water Levels in the Grant Line Canal near the Grant Line Canal Barrier Water levels in the Grant Line Canal near the Grant Line Canal Barrier could be slightly lower under the No-Action Alternative than the existing condition. This impact would be less than significant.

As shown in Table 6-31, maximum monthly reductions in minimum daily water level associated with No-Action compared to the existing conditions would exceed -0.1 feet; however, the reductions would not result in water levels less than 0.0 feet elevation and would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Impact H&H-6 (No-Action): Change in Water Levels in the Middle River near the Howard Road Bridge Water levels in the Middle River near the Howard Road Bridge could be slightly lower under the No-Action Alternative than the existing condition. This impact would be less than significant.

As shown in Table 6-31, maximum monthly reductions in minimum daily water level associated with No-Action compared to the existing conditions would exceed -0.1 feet; however, the reductions would not result in water levels less than 0.3 feet elevation and would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Impact H&H-7 (No-Action): Change in X2 Position The X2 position would not change from west to east of Collinsville in December or January when the Delta would not be in balanced conditions. Examination of simulation output indicates that compared to the existing condition, in no months would the No-

Action Alternative cause the X2 position to shift from west to east of Collinsville, when the Delta would not be in balanced conditions. No impact would occur. Mitigation is not required for the No-Action Alternative.

Impact H&H-8 (No-Action): Change in Recurrence of Delta Excess Conditions Few changes would occur from excess to balanced Delta conditions under the No-Action Alternative. This impact would be less than significant.

As shown in Table 6-32, CP1 would cause the Delta to change from excess to balanced conditions 16 times in the simulation; however, no month would change more than 5 percent of the time and at most only once during the 82-year period, according to the simulation. This impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Table 6-32. Simulated Number of Years the Delta Changes from Excess to Balanced Condition

Number of Years the Delta Changes from Excess to Balanced Conditions Compared to Existing Condition											
Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
0 (0%)	0 (0%)	1 (1%)	1 (1%)	1 (1%)	3 (4%)	1 (1%)	3 (4%)	1 (1%)	0 (0%)	4 (5%)	1 (1%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations
Notes:
Simulation Period: 1922-2003
(%) indicates percent of months Delta condition change occurs from existing condition
Key:
SLWRI = Shasta Lake Water Resources Investigation

CVP/SWP Service Areas

Impact H&H-9 (No-Action): Change in Deliveries to North-of-Delta CVP Water Service Contractors and Refuges Average annual deliveries to North-of-Delta CVP water service contractors would decrease under the No-Action Alternative relative to the existing condition. Average annual deliveries to north-of-Delta refuges would increase under the No-Action Alternative relative to the existing condition. The impact on North-of-Delta CVP water service contractors would be potentially significant.

As shown in Table 6-33, average annual deliveries to North-of-Delta CVP water service contractors would decrease under the No-Action Alternative. Deliveries to refuges under the No-Action Alterative would be greater than under existing conditions. This impact to water service contractors would be potentially significant. Mitigation is not required for the No-Action Alternative.

Table 6-33. Simulated Monthly Average Deliveries and Percent Change of Deliveries to North-of-Delta CVP Water Service Contractors and Refuges

Month	Change from Existing Conditions	
	Average All Years (cfs (%))	Dry and Critical Years (cfs (%))
North-of-Delta CVP Water Service Contractors Deliveries		
Oct	-3 (-4%)	-6 (-9%)
Nov	0 (-12%)	-1 (-16%)
Dec	0 (0%)	0 (0%)
Jan	0 (0%)	0 (0%)
Feb	-1 (-28%)	-2 (-27%)
Mar	-5 (-24%)	-7 (-33%)
Apr	-37 (-11%)	-48 (-21%)
May	-17 (-3%)	-48 (-15%)
Jun	-11 (-1%)	-60 (-14%)
Jul	-8 (-1%)	-66 (-14%)
Aug	-6 (-1%)	-53 (-14%)
Sep	-7 (-2%)	-26 (-15%)
Total (TAF)	-6 (-2%)	-19 (-15%)
North-of-Delta Refuges Deliveries		
Oct	46 (26%)	30 (17%)
Nov	51 (31%)	57 (37%)
Dec	28 (27%)	28 (27%)
Jan	13 (26%)	13 (26%)
Feb	12 (27%)	12 (27%)
Mar	3 (25%)	3 (24%)
Apr	3 (22%)	3 (24%)
May	14 (27%)	13 (28%)
Jun	17 (22%)	11 (15%)
Jul	28 (27%)	28 (28%)
Aug	37 (26%)	31 (23%)
Sep	51 (27%)	49 (27%)
Total (TAF)	18 (27%)	17 (25%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Nodes DEL_CVP_PAG_N and DEL_CVP_PRF_N)

Note:

Simulation period: 1922-2003. Change as measured from either existing condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index

Key:

% = percent

cfs = cubic feet per second

CVP = Central Vallye Project

SLWRI = Shasta Lake Water Resources Investigation

TAF = thousand acre-feet

Impact H&H-10 (No-Action): Change in Deliveries to South-of-Delta CVP Water Service Contractors and Refuges Average annual deliveries to south-of-Delta CVP water service contractors would decrease by more than 10 percent in dry and critical years under the No-Action Alternative, relative to the existing condition. Average annual deliveries to Refuges would decrease by 8 percent. This impact would be potentially significant.

As shown in Table 6-34, annual deliveries to south-of-Delta CVP water service contractors and refuges would decrease in average annual and dry and critical years, respectively. This impact would be potentially significant. Mitigation is not required for the No-Action Alternative.

Table 6-34. Simulated Monthly Average Deliveries and Percent Change of Deliveries to South-of-Delta CVP Water Service Contractors and Refuges

Month	Change from Existing Conditions	
	Average All Years (cfs (%))	Dry and Critical Years (cfs (%))
South-of-Delta CVP Water Service Contractors Deliveries		
Oct		
Nov	-8 (-2%)	-15 (-6%)
Dec	-11 (-2%)	-21 (-6%)
Jan	-20 (-2%)	-37 (-6%)
Feb	-25 (-2%)	-46 (-6%)
Mar	-26 (-4%)	-60 (-17%)
Apr	-27 (-3%)	-83 (-13%)
May	-35 (-2%)	-108 (-12%)
Jun	-50 (-2%)	-157 (-11%)
Jul	-73 (-2%)	-228 (-13%)
Aug	-15 (-1%)	-173 (-16%)
Sep	-13 (-2%)	-58 (-14%)
Total (TAF)	-19 (-2%)	-61 (-11%)
South-of-Delta Refuges Deliveries		
Oct	-85 (-8%)	-84 (-8%)
Nov	-58 (-8%)	-57 (-8%)
Dec	-30 (-9%)	-30 (-9%)
Jan	-10 (-7%)	-10 (-7%)
Feb	-6 (-6%)	-6 (-6%)
Mar	-6 (-6%)	-5 (-6%)
Apr	-15 (-7%)	-14 (-7%)
May	-38 (-9%)	-36 (-9%)
Jun	-37 (-7%)	-35 (-7%)
Jul	-8 (-6%)	-7 (-6%)
Aug	-16 (-8%)	-23 (-13%)
Sep	-77 (-9%)	-83 (-10%)
Total (TAF)	-23 (-8%)	-24 (-8%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Nodes DEL_CVP_PAG_S and DEL_CVP_PRF_S)

Note:

Simulation period: 1922-2003. Change as measured from either existing condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index

Key:
% = percent
cfs = cubic feet per second
CVP = Central Valley Project
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre-feet

Impact H&H-11 (No-Action): Change in Deliveries to SWP Table A Contractors Average deliveries to SWP Table A contractors would increase under the No-Action Alternative relative to the existing condition. This impact would be beneficial.

As shown in Table 6-35, average annual and monthly deliveries to SWP Table A contractors would increase under the No-Action Alternative relative to existing conditions for the average of all years, and for dry and critical years. This impact would be beneficial. Mitigation is not required for the No-Action Alternative.

Table 6-35. Simulated Monthly Average Deliveries and Percent Change of Deliveries to SWP Table A Contractors

Month	Change from Existing Conditions	
	Average All-Years (cfs (%))	Dry and Critical Years (cfs (%))
Oct	125 (4%)	178 (6%)
Nov	123 (5%)	60 (3%)
Dec	410 (17%)	378 (19%)
Jan	365 (59%)	22 (6%)
Feb	753 (68%)	129 (20%)
Mar	503 (28%)	60 (6%)
Apr	361 (8%)	96 (2%)
May	498 (9%)	160 (3%)
Jun	179 (2%)	63 (1%)
Jul	306 (4%)	177 (3%)
Aug	226 (3%)	73 (1%)
Sep	236 (5%)	63 (2%)
Total (TAF)	245 (8%)	88 (4%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Nodes DEL_SWP_PAG and DEL_SWP_PMI)

Note:

Simulation period: 1922-2003. Change as measured from either existing condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index

Key:

% = percent

cfs = cubic feet per second

SLWRI = Shasta Lake Water Resources Investigation

SWP = State Water Project

TAF = thousand acre-feet

Impact H&H-12(No-Action): Change in Groundwater Changes in groundwater levels would not be measurable under the No-Action Alternative as compared to the existing condition. This impact would be less than significant.

As shown in Tables 6-33, 6-34, and 6-35, total surface water deliveries to CVP and SWP contractors increase for the No-Action Alternative as compared to the existing condition. However, these increases in deliveries are likely associated with increases in demands rather than increases in water supply. Although groundwater pumping would still be required, the volume of pumping in the CVP/SWP service area would not be expected to change noticeably. This impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Impact H&H-13 (No-Action): Change in Groundwater Quality Changes in groundwater quality under the No-Action Alternative as compared to the existing condition would not be measurable. This impact would be less than significant.

As shown in Tables 6-11, 6-12, 6-23, 6-24, 6-28, and 6-29, total surface water deliveries to CVP and SWP contractors increase for the No-Action Alternative compared to the existing condition. However, these increases in deliveries are likely associated with increases in demands rather than increases in water supply. Although groundwater pumping would still be required, the volume of pumping in the CVP/SWP service area would not be expected to change noticeably. This impact would be less than significant. Mitigation is not required for the No-Action Alternative.

CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

CP1 primarily consists of raising Shasta Dam by 6.5 feet, which, in combination with spillway modifications, would increase the height of the reservoir's full pool by 8.5 feet and enlarge the total storage capacity in the reservoir by 256,000 acre-feet. The existing TCD would also be extended to achieve efficient use of the expanded cold-water pool. Shasta Dam operational guidelines would continue essentially unchanged, except during dry years and critical years, when 70,000 acre-feet and 35,000 acre-feet, respectively, of the increased storage capacity in Shasta Reservoir would be reserved to specifically focus on increasing M&I deliveries.

Shasta Lake and Vicinity The significance criteria for H&H do not apply in the Shasta Lake and vicinity geographic region; therefore, potential effects in that geographic region are not discussed further in this EIS.

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact H&H-1 (CP1): Change in Frequency of Flows above 100,000 cfs on the Sacramento River below Bend Bridge Although flood management operations would not change under CP1, a slight reduction could occur in the frequency of flows greater than 100,000 cfs. This impact would be beneficial.

SLWRI modeling uses a monthly time step, which is inappropriate for flood control analysis; however, flood management operations for downstream objectives would not change under CP1. Although a slight decrease in recurrence of high flows would be possible because of the increased storage capability, CP1 would not increase the frequency of flows above 100,000 cfs.

This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-2 (CP1): Place Housing or Other Structures within a 100-Year Flood Hazard Area as Mapped on a Federal Flood Hazard Boundary or Flood Insurance Rate Map or Other Flood Hazard Delineation Map No new structures would be built downstream from Shasta Dam. All project construction would be completed at the Shasta Dam site, and although the reservoir area would be expanded, any structures located within the reservoir area would be removed. Because reservoir operations for downstream objectives would not change, no additional structures downstream from the dam would be located within the 100-year flood hazard area. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-3 (CP1): Place within a 100-Year Flood Hazard Area Structures that Would Impede or Redirect Flood Flows No new structures would be built downstream from Shasta Dam. All project construction would be done at the Shasta Dam site, and although the reservoir area would be expanded, any structures located within the reservoir area would be removed. Because reservoir operations for downstream objectives would not change, no additional structures downstream from the dam would be located within the 100-year flood hazard area that would impede or redirect flood flows. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta

Impact H&H-4 (CP1): Change in Water Levels in the Old River near Tracy Road Bridge Simulated water levels in the Old River near Tracy Road Bridge show very small reductions that would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant.

As shown in Table 6-36, maximum monthly reduction in minimum daily water level associated with CP1 would be less than 0.1 foot in all months during the irrigation season, compared to the existing condition and the No-Action Alternative. The water levels would remain above 0.0 feet elevation and would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-36. Simulated Monthly Maximum 15-Minute Change in Old River Water Levels near Tracy Road Bridge at Low-Low Tide

Month	Change from Existing Condition	Change from No-Action Alternative
	CP1 (2005) Change (feet)	CP1 (2030) Change (feet)
Apr	0 00 (0%)	-0.01 (0%)
May	-0.01 (0%)	-0.01 (0%)
Jun	0 00 (0%)	-0.05 (0%)
Jul	-0.05 (0%)	-0.03 (0%)
Aug	-0.04 (0%)	-0.05 (0%)
Sep	-0.04 (0%)	-0.06 (0%)
Oct	-0.05 (0%)	-0.05 (0%)

Source: Version 8.0.6 DSM2 2005 and 2030 simulations (Node 071_3116)

Note:
Simulation period: 1922-2003
(%) indicates the percentage of months out of 82 years with a maximum decrease in water level exceeding 0.1 feet.
Key:
CP = comprehensive plan

Impact H&H-5 (CP1): Change in Water Levels in the Grant Line Canal near the Grant Line Canal Barrier Simulated water levels in the Grant Line Canal near the Grant Line Canal Barrier show very small reductions that would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant.

As shown in Table 6-37, maximum monthly reduction in minimum daily water level associated with CP1 would be less than 0.1 foot in all months during the irrigation season, compared to the existing condition and the No-Action Alternative. The water levels would remain above 0.0 feet elevation and would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-37. Simulated Monthly Maximum 15-Minute Change in the Grant Line Canal Water Levels near the Grant Line Canal Barrier at Low-Low Tide

Month	Change from Existing Condition	Change from No-Action Alternative
	CP1 (2005) Change (feet)	CP1 (2030) Change (feet)
Apr	0.00 (0%)	0.00 (0%)
May	-0.01 (0%)	-0.01 (0%)
Jun	0.00 (0%)	-0.03 (0%)
Jul	-0.06 (0%)	-0.03 (0%)
Aug	-0.03 (0%)	-0.03 (0%)
Sep	-0.02 (0%)	-0.04 (0%)
Oct	-0.02 (0%)	-0.02 (0%)

Source: Version 8.0.6 DSM2 2005 and 2030 simulations (Node 129_5691)

Notes:
Simulation period: 1922-2003
(%) indicates the percentage of months out of 82 years with a maximum decrease in water level exceeding 0.1 feet.
Key:
CP = comprehensive plan

Impact H&H-6 (CP1): Change in Water Levels in the Middle River near the Howard Road Bridge Simulated water levels in the Middle River near the Howard Road Bridge show very small reductions that would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant.

As shown in Table 6-38, maximum monthly reduction in minimum daily water level associated with CP1 would be less than 0.1 foot in all months during the irrigation season, compared to the existing condition and the No-Action alternative. The water levels would remain above 0.3 feet elevation and would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-38. Simulated Monthly Maximum 15-Minute Change in Middle River Water Levels near the Howard Road Bridge at Low-Low Tide

Month	Change from Existing Condition	Change from No-Action Alternative
	CP1 (2005) Change (feet)	CP1 (2030) Change (feet)
Apr	0 00 (0%)	-0.01 (0%)
May	-0.01 (0%)	-0.01 (0%)
Jun	0 00 (0%)	-0.05 (0%)
Jul	-0.05 (0%)	-0.03 (0%)
Aug	-0.04 (0%)	-0.04 (0%)
Sep	-0.04 (0%)	-0.07 (0%)
Oct	-0.05 (0%)	-0.05 (0%)

Source: Version 8.0.6 DSM2 2005 and 2030 simulations (Node 206_5533)

Notes:
Simulation period: 1922-2003
(%) indicates the percentage of months out of 82 years with a maximum decrease in water level exceeding 0.1 feet.
Key:
CP = comprehensive plan

Impact H&H-7 (CP1): Change in X2 Position The X2 position would not change from west to east of Collinsville in December or January when the Delta was not in balanced conditions. Examination of simulation output indicates that compared to the existing condition, or No-Action Alternative, CP1 shows no months when the X2 position shifts from west to east of Collinsville when the Delta would not be in balanced conditions. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-8 (CP1): Change in Recurrence of Delta Excess Conditions Changes from excess to balanced Delta conditions would be rare. This impact would be less than significant.

As shown in Table 6-39, CP1 would cause one April, one June, two Julys, three Augusts, one October, and one November to switch from excess to balanced Delta conditions when compared to the existing condition, and two Augusts, two Novembers, and one each of October and December when compared to the No-Action Alternative. Because of the low number of occurrences, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-39. Simulated Number of Years the Delta Changes from Excess to Balanced Condition

	Number of Years the Delta Changes from Excess to Balanced Conditions Compared to Existing Condition or No-Action Alternative											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
CP1 (2005)	0 (0%)	0 (0%)	0 (0%)	1 (1%)	0 (0%)	1 (1%)	2 (2%)	3 (4%)	0 (0%)	1 (1%)	1 (1%)	0 (0%)
CP1 (2030)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2 (2%)	0 (0%)	1 (1%)	2 (2%)	1 (1%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations
Notes:
Simulation Period: 1922-2003
(%) indicates percent of months Delta condition change occurs
Key:
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation

CVP/SWP Service Areas

Impact H&H-9 (CP1): Change in Deliveries to North-of-Delta CVP Water Service Contractors and Refuges Average annual deliveries to North-of-Delta water service contractors would increase under all conditions. Average annual deliveries to Refuges would not change under all conditions. This impact would be less than significant.

As shown in Table 6-40, average annual deliveries to North-of-Delta water service contractors under both existing and future conditions would increase relative to the basis of comparison. Deliveries to Refuges North-of-Delta would not significantly change under all conditions on an annual average basis. Minor increases and decreases in Refuge deliveries are not true representation of real-time operations but an indication of modeling artifacts. Such reduction would not occur in real time due to efficient water allocation and management schemes that cannot be captured adequately in a water resources planning model such as CalSim-II. This impact is less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-40. Simulated Monthly Average Deliveries and Percent Change of Deliveries to North-of-Delta CVP Water Service Contractors and Refuges

Month	Existing Condition (2005)				Future Condition (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (cfs)	CP1 Change (cfs (%))	Existing Condition (cfs)	CP1 Change (cfs (%))	No-Action Alternative (cfs)	CP1 Change (cfs (%))	No-Action Alternative (cfs)	CP1 Change (cfs (%))
North-of-Delta CVP Water Service Contractors Deliveries								
Oct	77	3 (3%)	69	3 (4%)	74	2 (3%)	63	2 (3%)
Nov	3	0 (1%)	3	0 (2%)	2	0 (2%)	3	0 (2%)
Dec	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
Jan	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
Feb	3	0 (2%)	7	0 (1%)	2	0 (1%)	5	0 (0%)
Mar	19	1 (5%)	21	2 (10%)	15	1 (5%)	14	1 (10%)
Apr	335	12 (3%)	229	14 (6%)	297	13 (4%)	181	11 (6%)
May	572	15 (3%)	316	19 (6%)	555	15 (3%)	268	11 (4%)
Jun	799	19 (2%)	425	26 (6%)	788	19 (2%)	365	13 (4%)
Jul	918	21 (2%)	480	29 (6%)	910	20 (2%)	414	15 (4%)
Aug	733	17 (2%)	386	23 (6%)	727	16 (2%)	333	12 (4%)
Sep	341	8 (2%)	170	11 (6%)	334	8 (2%)	144	6 (4%)
Total (TAF)	231	6 (2%)	128	8 (6%)	225	6 (3%)	109	4 (4%)
North-of-Delta Refuges Deliveries								
Oct	177	-10 (-5%)	182	-25 (-14%)	224	2 (1%)	212	8 (4%)
Nov	168	2 (1%)	156	5 (3%)	219	-1 (0%)	212	-4 (-2%)
Dec	105	0 (0%)	104	0 (0%)	133	0 (0%)	132	0 (0%)
Jan	50	0 (0%)	50	0 (0%)	63	0 (0%)	62	0 (0%)
Feb	45	0 (0%)	45	0 (0%)	57	0 (0%)	57	0 (0%)
Mar	13	0 (0%)	12	0 (0%)	16	0 (0%)	15	0 (1%)
Apr	15	0 (0%)	14	0 (0%)	18	0 (0%)	17	0 (-1%)
May	50	-1 (-1%)	46	-2 (-3%)	64	0 (0%)	59	0 (0%)
Jun	79	-1 (-1%)	75	-2 (-3%)	96	1 (1%)	87	3 (3%)
Jul	106	-1 (-1%)	99	-3 (-3%)	134	-1 (-1%)	126	-4 (-3%)
Aug	143	0 (0%)	134	0 (0%)	180	2 (1%)	165	6 (4%)
Sep	187	0 (0%)	177	0 (0%)	237	0 (0%)	226	0 (0%)
Total (TAF)	69	-1 (-1%)	66	-2 (-2%)	87	0 (0%)	83	1 (1%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Nodes DEL_CVP_PAG_N and DEL_CVP_PRF_N)

Notes:

Simulation period: 1922-2003. Change as measured from either existing condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

(%) indicates percent change from either existing condition or No-Action Alternative

Key:

cfs = cubic feet per second

CP = comprehensive plan

CVP = Central Valley Project

SLWRI = Shasta Lake Water Resources Investigation

TAF = thousand acre-feet

Impact H&H-10 (CP1): Change in Deliveries to South-of-Delta CVP Water Service Contractors and Refuges Average annual and monthly deliveries to South-of-Delta water service contractors would increase under both existing and future conditions. Average annual deliveries to South-of-Delta refuges would not change under the project conditions. This impact would be beneficial.

As shown in Table 6-41, average annual deliveries to South-of-Delta water service contractors under both existing and future conditions would increase relative to the basis of comparison. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed. Average annual deliveries to South-of-Delta refuges would not change under all conditions. Minor increases and decreases in Refuge deliveries are not a true representation of real-time operations but an indication of modeling artifacts. Such reduction would not occur in real time due to efficient water allocation and management schemes that cannot be captured adequately in a water resources planning model such as CalSim-II. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-41. Simulated Monthly Average Deliveries and Percent Change of Deliveries to South-of-Delta CVP Water Service Contractors and Refuges

Month	Existing Condition (2005)				Future Condition (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (cfs)	CP1 Change (cfs (%))	Existing Condition (cfs)	CP1 Change (cfs (%))	No-Action Alternative (cfs)	CP1 Change (cfs (%))	No-Action Alternative (cfs)	CP1 Change (cfs (%))
South-of-Delta CVP Water Service Contractors Deliveries								
Oct	474	3 (1%)	363	6 (2%)	464	6 (1%)	343	8 (2%)
Nov	362	3 (1%)	277	4 (2%)	354	4 (1%)	262	6 (2%)
Dec	501	3 (1%)	383	6 (2%)	490	6 (1%)	362	8 (2%)
Jan	880	6 (1%)	673	10 (2%)	860	10 (1%)	636	14 (2%)
Feb	1,100	8 (1%)	841	13 (2%)	1,076	13 (1%)	794	18 (2%)
Mar	660	13 (2%)	362	15 (4%)	634	15 (2%)	302	6 (2%)
Apr	1,079	11 (1%)	627	-1 (0%)	1,052	15 (1%)	545	5 (1%)
May	1,564	11 (1%)	902	-2 (0%)	1,528	19 (1%)	794	11 (1%)
Jun	2,596	28 (1%)	1,467	23 (2%)	2,545	32 (1%)	1,310	19 (1%)
Jul	3,136	20 (1%)	1,809	-10 (-1%)	3,063	37 (1%)	1,581	19 (1%)
Aug	2,078	1 (0%)	1,112	-40 (-4%)	2,063	9 (0%)	939	31 (3%)
Sep	735	0 (0%)	428	-8 (-2%)	722	10 (1%)	370	7 (2%)
Total (TAF)	916	6 (1%)	558	1 (0%)	898	11 (1%)	497	9 (2%)
South-of-Delta Refuges Deliveries								
Oct	1,126	0 (0%)	1,110	0 (0%)	1,041	0 (0%)	1,026	0 (0%)
Nov	729	0 (0%)	718	0 (0%)	671	0 (0%)	661	0 (0%)
Dec	336	0 (0%)	331	0 (0%)	306	0 (0%)	302	0 (0%)
Jan	147	0 (0%)	145	0 (0%)	137	0 (0%)	135	0 (0%)
Feb	109	0 (0%)	107	0 (0%)	102	0 (0%)	101	0 (0%)
Mar	93	0 (0%)	89	0 (0%)	88	0 (0%)	83	0 (0%)
Apr	217	0 (0%)	207	0 (0%)	203	0 (0%)	193	0 (0%)
May	445	0 (0%)	423	0 (0%)	407	0 (0%)	387	0 (0%)
Jun	493	0 (0%)	468	1 (0%)	456	0 (0%)	434	0 (0%)
Jul	120	0 (0%)	114	0 (0%)	112	0 (0%)	107	0 (0%)
Aug	197	2 (1%)	185	1 (1%)	181	2 (1%)	161	7 (4%)
Sep	885	-9 (-1%)	843	-6 (-1%)	808	0 (0%)	760	0 (0%)
Total (TAF)	296	0 (0%)	286	0 (0%)	273	0 (0%)	263	0 (0%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Nodes DEL_CVP_PAG_S and DEL_CVP_PRF_S)

Notes:

Simulation period: 1922-2003. Change as measured from either existing condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

(%) indicates percent change from either existing condition or No-Action Alternative

Key:
cfs = cubic feet per second
CP = comprehensive plan
CVP = Central Valley Project
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre-feet

Impact H&H-11 (CP1): Change in Deliveries to SWP Table A Contractors

Average annual deliveries would increase under both existing and future conditions, but some less than significant decreases could occur in monthly deliveries under future conditions. This impact would be less than significant.

As shown in Table 6-42, average annual deliveries to SWP Table A contractors would increase under CP1 in both existing and future conditions relative to the bases of comparison in both average years and in dry and critical years. Under both existing and future conditions some decreases could occur in deliveries under CP1.These decreases would be less than 1 percent. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-42. Simulated Monthly Average Deliveries and Percent Change of Deliveries to SWP Table A Contractors

Month	Existing Condition (2005)				Future Condition (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (cfs)	CP1 Change (cfs (%))	Existing Condition (cfs)	CP1 Change (cfs (%))	No-Action Alternative (cfs)	CP1 Change (cfs (%))	No-Action Alternative (cfs)	CP1 Change (cfs (%))
Oct	3,226	1 (0%)	2,873	50 (2%)	3,351	17 (1%)	3,051	32 (1%)
Nov	2,689	35 (1%)	2,282	54 (2%)	2,812	1 (0%)	2,342	2 (0%)
Dec	2,476	28 (1%)	2,014	82 (4%)	2,886	28 (1%)	2,392	71 (3%)
Jan	623	9 (2%)	389	-3 (-1%)	988	31 (3%)	412	13 (3%)
Feb	1,106	21 (2%)	637	29 (5%)	1,860	27 (1%)	766	21 (3%)
Mar	1,804	18 (1%)	1,041	31 (3%)	2,307	14 (1%)	1,101	30 (3%)
Apr	4,733	18 (0%)	4,156	48 (1%)	5,094	27 (1%)	4,251	74 (2%)
May	5,837	33 (1%)	4,983	19 (0%)	6,335	23 (0%)	5,143	72 (1%)
Jun	7,433	-7 (0%)	6,408	-48 (-1%)	7,612	38 (1%)	6,471	46 (1%)
Jul	7,841	41 (1%)	6,757	110 (2%)	8,147	12 (0%)	6,933	64 (1%)
Aug	7,017	14 (0%)	5,605	45 (1%)	7,244	-12 (0%)	5,679	10 (0%)
Sep	5,086	22 (0%)	4,003	62 (2%)	5,322	37 (1%)	4,066	119 (3%)
Total (TAF)	3,020	14 (0%)	2,493	29 (1%)	3,265	15 (0%)	2,581	34 (1%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Nodes DEL_SWP_PAG and DEL_SWP_PMI)
Notes:
Simulation period: 1922-2003. Change as measured from either existing condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.
(%) indicates percent change from either existing condition or No-Action Alternative
Key:
cfs = cubic feet per second
CP = comprehensive plan
CVP = Central Valley Project
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre-feet

Impact H&H-12 (CP1): Change in Groundwater Levels CP1 would deliver additional surface water to CVP and SWP water contractors, reducing their need to pump groundwater. The reduction in groundwater pumping would result in increased groundwater levels. This impact would be beneficial.

With increased water supply deliveries to CVP and SWP water contractors, and an associated increase in surface water supply reliability to those contractors, shortages in deliveries would decrease under CP1. Contractor responses to shortages in surface water deliveries would vary; some may elect to fallow their land, others may buy water on the transfer market, and some may pump groundwater. An increase in surface water deliveries would result in a decrease in groundwater pumping. With less groundwater pumping, groundwater basins that were in overdraft conditions would be anticipated to improve as a result of increasing groundwater levels. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-13 (CP1): Change in Groundwater Quality CP1 would deliver additional surface water to CVP and SWP water contractors, reducing their need to pump groundwater. This impact would be less than significant for groundwater quality.

With increased water supply deliveries to CVP and SWP water contractors, and an associated increase in surface water supply reliability to those contractors, shortages in deliveries would decrease under CP1. Contractor responses to shortages in surface water deliveries would vary; some may elect to fallow their land, others may buy water on the transfer market, and some may pump groundwater. An increase in surface water deliveries would result in a decrease in groundwater pumping. Because CP1 would have a positive, albeit limited, impact by reducing reliance on groundwater, the effects of CP1 on groundwater quality also would be limited. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

CP2 primarily consists of raising Shasta Dam by 12.5 feet, which, in combination with spillway modifications, would increase the height of the reservoir's full pool by 14.5 feet and would enlarge the total storage capacity in the reservoir by 443,000 acre-feet. The existing TCD also would be extended to achieve efficient use of the expanded cold-water pool. Shasta Dam operational guidelines would continue essentially unchanged, except during dry years and critical years, when 120,000 acre-feet and 60,000 acre-feet, respectively, of the increased storage capacity in Shasta Reservoir would be reserved to specifically focus on increasing M&I deliveries.

Shasta Lake and Vicinity The significance criteria for H&H do not apply in the Shasta Lake and vicinity geographic region; therefore, potential effects in that geographic region are not discussed further in this EIS.

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact H&H-1 (CP2): Change in Frequency of Flows above 100,000 cfs on the Sacramento River below Bend Bridge Although flood management operations would not change under CP2, a slight reduction could occur in the frequency of flows greater than 100,000 cfs. This impact would be beneficial.

SLWRI modeling uses a monthly time step, which is inappropriate for flood control analysis; however, flood management operations for downstream objectives would not change under CP2. Although a slight decrease in recurrence of high flows would be possible because of the increased storage capability, CP2 would not increase the frequency of flows above 100,000 cfs. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-2 (CP2): Place Housing or Other Structures within a 100-Year Flood Hazard Area as Mapped on a Federal Flood Hazard Boundary or Flood Insurance Rate Map or Other Flood Hazard Delineation Map This impact would be the same as Impact H&H-2 (CP1); no new structures would be built downstream from Shasta Dam. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-3 (CP2): Place within a 100-Year Flood Hazard Area Structures that Would Impede or Redirect Flood Flows This impact would be the same as Impact H&H-3 (CP1); no new structures would be built downstream from Shasta Dam. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta

Impact H&H-4 (CP2): Change in Water Levels in Old River near Tracy Road Bridge Simulated water levels in the Old River near Tracy Road Bridge show very small reductions that would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant.

As shown in Table 6-43, maximum monthly reduction in minimum daily water level associated with CP2 would be less than 0.1 foot in all months during the irrigation season, compared to the existing condition and the No-Action Alternative. The water levels would remain above 0.0 feet elevation and would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-43. Simulated Monthly Maximum 15-Minute Change in Old River Water Levels near Tracy Road Bridge at Low-Low Tide

Month	Change from Existing Condition	Change from No-Action Alternative
	CP2 (2005) Change (feet)	CP2 (2030) Change (feet)
Apr	0 00 (0%)	-0.02 (0%)
May	-0.01 (0%)	-0.02 (0%)
Jun	-0.05 (0%)	-0.05 (0%)
Jul	-0.06 (0%)	-0.06 (0%)
Aug	-0.06 (0%)	-0.05 (0%)
Sep	-0.05 (0%)	-0.08 (0%)
Oct	-0.08 (0%)	-0.04 (0%)

Source: Version 8.0.6 DSM2 2005 and 2030 simulations (Node 071_3116)
Notes:
Simulation period: 1922-2003
(%) indicates the percentage of months out of 82 years with a maximum decrease in water level exceeding 0.1 feet.
Key:
CP = comprehensive plan

Impact H&H-5 (CP2): Change in Water Levels in the Grant Line Canal near the Grant Line Canal Barrier Simulated water levels in the Grant Line Canal near the Grant Line Canal Barrier show very small reductions that would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant.

As shown in Table 6-44, maximum monthly changes in minimum daily water level associated with CP2 would be less than 0.1 foot in all months during the irrigation season, compared to the existing condition and the No-Action Alternative. The water levels would remain above 0.0 feet elevation and would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-44. Simulated Monthly Maximum 15-Minute Change in Grant Line Canal Water Levels near the Grant Line Canal Barrier at Low-Low Tide

Month	Change from Existing Condition	Change from No-Action Alternative
	CP2 (2005) Change (feet)	CP2 (2030) Change (feet)
Apr	0.00 (0%)	-0.02 (0%)
May	-0.02 (0%)	-0.02 (0%)
Jun	-0.04 (0%)	-0.03 (0%)
Jul	-0.07 (0%)	-0.06 (0%)
Aug	-0.04 (0%)	-0.03 (0%)
Sep	-0.03 (0%)	-0.05 (0%)
Oct	-0.03 (0%)	-0.02 (0%)

Source: Version 8.0.6 DSM2 2005 and 2030 simulations (Node 129_5691)
Notes:
Simulation period: 1922-2003
(%) indicates the percentage of months out of 82 years with a maximum decrease in water level exceeding 0.1 feet.
Key:
CP = comprehensive plan

Impact H&H-6 (CP2): Change in Water Levels in the Middle River near the Howard Road Bridge Simulated water levels in the Middle River near the Howard Road Bridge show very small reductions that would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant.

As shown in Table 6-45, maximum monthly changes in minimum daily water level associated with CP2 would be less than 0.1 foot in all months during the irrigation season, compared to the existing condition and the No-Action Alternative. The water levels would remain above 0.3 feet elevation and would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-45. Simulated Monthly Maximum 15-Minute Change in Middle River Water Levels near the Howard Road Bridge at Low-Low Tide

Month	Change from Existing Condition	Change from No-Action Alternative
	CP2 (2005) Change (feet)	CP2 (2030) Change (feet)
Apr	0.00 (0%)	-0.02 (0%)
May	-0.01 (0%)	-0.02 (0%)
Jun	-0.05 (0%)	-0.05 (0%)
Jul	-0.06 (0%)	-0.06 (0%)
Aug	-0.06 (0%)	-0.05 (0%)
Sep	-0.05 (0%)	-0.09 (0%)
Oct	-0.08 (0%)	-0.05 (0%)

Source: Version 8.0.6 DSM2 2005 and 2030 simulations (Node 206_5533)
Notes:
Simulation period: 1922-2003
(%) indicates the percentage of months out of 82 years with a maximum decrease in water level exceeding 0.1 feet.
Key:
CP = comprehensive plan

Impact H&H-7 (CP2): Change in X2 Position The X2 position would change from west to east of Collinsville in one December compared to the existing conditions, when the Delta would not be in balanced conditions. This impact would be less than significant.

Examination of simulation output indicates that compared to the existing condition, only in one month, December 1979, would the X2 position change from west to east of Collinsville. Under the existing conditions, the X2 position would be at 78.25 kilometers (km), and under CP2, it would be at 81.27 km, a 3.03 km shift; however, the Delta was not in balanced conditions. When compared to the No-Action Alternative, CP2 shows no months when the No-Action Alternative would cause the X2 position to shift from west of Collinsville to east of Collinsville when the Delta is not in balanced conditions.

This single month change would not significantly limit CCWD's ability to fill Los Vaqueros Reservoir. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-8 (CP2): Change in Recurrence of Delta Excess Conditions Changes from excess to balanced Delta conditions would be rare. This impact would be less than significant.

As shown in Table 6-46, CP2 would cause few changes from excess to balanced Delta conditions when compared to the existing condition and the No-Action Alternative. Because of the low number of occurrences, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-46. Simulated Number of Years the Delta Changes from Excess to Balanced Condition

	Number of Years the Delta Changes from Excess to Balanced Conditions Compared to Existing Condition or No-Action Alternative											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CP2 (2005)	1 (1%)	0 (0%)	1 (1%)	0 (0%)	0 (0%)	1 (1%)	0 (0%)	2 (2%)	0 (0%)	1 (1%)	2 (2%)	0 (0%)
CP2 (2030)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (1%)	2 (2%)	0 (0%)	3 (4%)	3 (4%)	1 (1%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations
Notes:
Simulation Period: 1922-2003
(%) indicates percent of months Delta condition change occurs
Key:
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation

CVP/SWP Service Areas

Impact H&H-9 (CP2): Change in Deliveries to North-of-Delta CVP Water Service Contractors and Refuges Average annual deliveries to North-of-Delta CVP Water Service Contractors would increase under all conditions. This impact would be beneficial. Annual average deliveries to North-of-Delta refuges would not change under all conditions. This impact would be less than significant.

As shown in Table 6-47, average annual deliveries to North-of-Delta CVP Service Water Contractors under both existing and future conditions would increase relative to the basis of comparison. This impact is less than significant. Mitigation for this impact is not needed, and thus not proposed. Average annual deliveries to North-of-Delta refuges would not change under all conditions. Minor increases and decreases in Refuge deliveries are not a true representation of real-time operations but an indication of modeling artifacts. Such reduction would not occur in real time due to efficient water allocation and management schemes that cannot be captured adequately in a water resources planning model such as CalSim-II. This impact is less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-47. Simulated Monthly Average Deliveries and Percent Change of Deliveries to North-of-Delta CVP Water Service Contractors and Refuges

Month	Existing Condition (2005)				Future Condition (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (cfs)	CP2 Change (cfs (%))	Existing Condition (cfs)	CP2 Change (cfs (%))	No-Action Alternative (cfs)	CP2 Change (cfs (%))	No-Action Alternative (cfs)	CP2 Change (cfs (%))
North-of-Delta CVP Water Service Contractors Deliveries								
Oct	77	4 (5%)	69	3 (5%)	74	4 (6%)	63	4 (6%)
Nov	3	0 (4%)	3	0 (6%)	2	0 (5%)	3	0 (9%)
Dec	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
Jan	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
Feb	3	0 (1%)	7	0 (0%)	2	0 (2%)	5	0 (0%)
Mar	19	2 (8%)	21	2 (11%)	15	2 (12%)	14	2 (17%)
Apr	335	19 (6%)	229	21 (9%)	297	23 (8%)	181	21 (12%)
May	572	24 (4%)	316	25 (8%)	555	30 (5%)	268	24 (9%)
Jun	799	30 (4%)	425	32 (8%)	788	37 (5%)	365	30 (8%)
Jul	918	33 (4%)	480	36 (7%)	910	40 (4%)	414	33 (8%)
Aug	733	26 (4%)	386	29 (7%)	727	31 (4%)	333	27 (8%)
Sep	341	12 (4%)	170	14 (8%)	334	15 (4%)	144	12 (8%)
Total (TAF)	231	9 (4%)	128	10 (8%)	225	11 (5%)	109	9 (9%)
North-of-Delta Refuges Deliveries								
Oct	177	-8 (-4%)	182	-17 (-9%)	224	2 (1%)	212	12 (5%)
Nov	168	3 (2%)	156	11 (7%)	219	1 (0%)	212	-2 (-1%)
Dec	105	0 (0%)	104	0 (0%)	133	0 (0%)	132	0 (0%)
Jan	50	0 (0%)	50	0 (0%)	63	0 (0%)	62	0 (0%)
Feb	45	0 (0%)	45	0 (0%)	57	0 (0%)	57	0 (0%)
Mar	13	0 (0%)	12	0 (1%)	16	0 (0%)	15	0 (1%)
Apr	15	0 (0%)	14	0 (1%)	18	0 (-1%)	17	0 (-1%)
May	50	0 (0%)	46	0 (0%)	64	0 (0%)	59	0 (0%)
Jun	79	-1 (-1%)	75	-3 (-4%)	96	1 (1%)	87	3 (3%)
Jul	106	0 (0%)	99	0 (0%)	134	-1 (-1%)	126	-4 (-3%)
Aug	143	-1 (-1%)	134	-2 (-2%)	180	3 (2%)	165	9 (6%)
Sep	187	0 (0%)	177	0 (0%)	237	0 (0%)	226	0 (0%)
Total (TAF)	69	0 (-1%)	66	-1 (-1%)	87	0 (0%)	83	1 (1%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Nodes DEL_CVP_PAG_N and DEL_CVP_PRF_N)

Notes:

Simulation period: 1922-2003. Change as measured from either existing condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

(%) indicates percent change from either existing condition or No-Action Alternative

Key:

cfs = cubic feet per second

CP = comprehensive plan

CVP = Central Valley Project

SLWRI = Shasta Lake Water Resources Investigation

TAF = thousand acre-feet

Impact H&H-10 (CP2): Change in Deliveries to South-of-Delta CVP Water Service Contractors and Refuges Average annual deliveries to South-of-Delta CVP Water Service Contractors would increase under all conditions. This impact would be beneficial. Annual average deliveries to South-of-Delta refuges would not change under all conditions. This impact would be less than significant.

As shown in Table 6-48, average annual deliveries to South-of-Delta CVP Water Service Contractors under both existing and future conditions would increase relative to the basis of comparison. This impact is less than significant. Mitigation for this impact is not needed, and thus not proposed. Average annual deliveries to South-of-Delta refuges would not change under all conditions. Minor increases and decreases in Refuge deliveries are not a true representation of real-time operations but an indication of modeling artifacts. Such reduction would not occur in real time due to efficient water allocation and management schemes that cannot be captured adequately in a water resources planning model such as CalSim-II. This impact is less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-48. Simulated Monthly Average Deliveries and Percent Change of Deliveries to South-of-Delta CVP Water Service Contractors and Refuges

Month	Existing Condition (2005)				Future Condition (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (cfs)	CP2 Change (cfs (%))	Existing Condition (cfs)	CP2 Change (cfs (%))	No-Action Alternative (cfs)	CP2 Change (cfs (%))	No-Action Alternative (cfs)	CP2 Change (cfs (%))
South-of-Delta CVP Water Service Contractors Deliveries								
Oct	474	10 (2%)	363	15 (4%)	464	19 (4%)	343	27 (8%)
Nov	362	8 (2%)	277	12 (4%)	354	15 (4%)	262	21 (8%)
Dec	501	10 (2%)	383	16 (4%)	490	20 (4%)	362	29 (8%)
Jan	880	18 (2%)	673	29 (4%)	860	35 (4%)	636	51 (8%)
Feb	1,100	23 (2%)	841	36 (4%)	1,076	44 (4%)	794	63 (8%)
Mar	660	35 (5%)	362	26 (7%)	634	49 (8%)	302	53 (18%)
Apr	1,079	31 (3%)	627	2 (0%)	1,052	54 (5%)	545	51 (9%)
May	1,564	32 (2%)	902	2 (0%)	1,528	63 (4%)	794	72 (9%)
Jun	2,596	64 (2%)	1,467	30 (2%)	2,545	106 (4%)	1,310	122 (9%)
Jul	3,136	65 (2%)	1,809	0 (0%)	3,063	114 (4%)	1,581	109 (7%)
Aug	2,078	62 (3%)	1,112	48 (4%)	2,063	89 (4%)	939	163 (17%)
Sep	735	9 (1%)	428	-5 (-1%)	722	30 (4%)	370	35 (10%)
Total (TAF)	916	22 (2%)	558	13 (2%)	898	39 (4%)	497	48 (10%)

Table 6-48. Simulated Monthly Average Deliveries and Percent Change of Deliveries to South-of-Delta CVP Water Service Contractors and Refuges (contd.)

Month	Existing Condition (2005)				Future Condition (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (cfs)	CP2 Change (cfs (%))	Existing Condition (cfs)	CP2 Change (cfs (%))	No-Action Alternative (cfs)	CP2 Change (cfs (%))	No-Action Alternative (cfs)	CP2 Change (cfs (%))
South-of-Delta Refuges Deliveries								
Oct	1,126	0 (0%)	1,110	0 (0%)	1,041	0 (0%)	1,026	0 (0%)
Nov	729	0 (0%)	718	0 (0%)	671	0 (0%)	661	0 (0%)
Dec	336	0 (0%)	331	0 (0%)	306	0 (0%)	302	0 (0%)
Jan	147	0 (0%)	145	0 (0%)	137	0 (0%)	135	0 (0%)
Feb	109	0 (0%)	107	0 (0%)	102	0 (0%)	101	0 (0%)
Mar	93	0 (0%)	89	0 (0%)	88	0 (0%)	83	0 (0%)
Apr	217	0 (0%)	207	0 (0%)	203	0 (0%)	193	0 (0%)
May	445	0 (0%)	423	0 (0%)	407	0 (0%)	387	0 (0%)
Jun	493	0 (0%)	468	1 (0%)	456	0 (0%)	434	0 (0%)
Jul	120	0 (0%)	114	0 (0%)	112	0 (0%)	107	0 (0%)
Aug	197	2 (1%)	185	3 (1%)	181	5 (3%)	161	13 (8%)
Sep	885	-11 (-1%)	843	-11 (-1%)	808	1 (0%)	760	2 (0%)
Total (TAF)	296	-1 (0%)	286	0 (0%)	273	0 (0%)	263	1 (0%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Nodes DEL_CVP_PAG_S and DEL_CVP_PRF_S)
Notes:
Simulation period: 1922-2003. Change as measured from either existing condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.
(%) indicates percent change from either existing condition or No-Action Alternative
Key:
cfs = cubic feet per second
CP = comprehensive plan
CVP = Central Valley Project
SLWRI = Shasta Lake Water Resources Investigation TAF = thousand acre-feet

Impact H&H-11 (CP2): Change in Deliveries to SWP Table A Contractors
Average annual and monthly deliveries would increase under both existing and future conditions. This impact would be less than significant.

As shown in Table 6-49, average annual deliveries to SWP Table A contractors would increase under CP2 in both existing and future conditions relative to the bases of comparison in both average years and in dry and critical years. Some decreases in monthly average deliveries could occur under CP2 relative to existing conditions and the No-Action Alternative in both average annual and dry and critical years. These decreases would be less than 1 percent. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-49. Simulated Monthly Average Deliveries and Percent Change of Deliveries to SWP Table A Contractors

Month	Existing Condition (2005)				Future Condition (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (cfs)	CP2 Change (cfs (%))	Existing Condition (cfs)	CP2 Change (cfs (%))	No-Action Alternative (cfs)	CP2 Change (cfs (%))	No-Action Alternative (cfs)	CP2 Change (cfs (%))
Oct	3,226	-7 (0%)	2,873	63 (2%)	3,351	44 (1%)	3,051	50 (2%)
Nov	2,689	51 (2%)	2,282	71 (3%)	2,812	18 (1%)	2,342	28 (1%)
Dec	2,476	33 (1%)	2,014	89 (4%)	2,886	38 (1%)	2,392	78 (3%)
Jan	623	18 (3%)	389	0 (0%)	988	49 (5%)	412	28 (7%)
Feb	1,106	32 (3%)	637	47 (7%)	1,860	52 (3%)	766	45 (6%)
Mar	1,804	28 (2%)	1,041	56 (5%)	2,307	27 (1%)	1,101	60 (5%)
Apr	4,733	24 (1%)	4,156	69 (2%)	5,094	35 (1%)	4,251	102 (2%)
May	5,837	43 (1%)	4,983	55 (1%)	6,335	31 (0%)	5,143	103 (2%)
Jun	7,433	-22 (0%)	6,408	-66 (-1%)	7,612	41 (1%)	6,471	61 (1%)
Jul	7,841	49 (1%)	6,757	146 (2%)	8,147	31 (0%)	6,933	133 (2%)
Aug	7,017	12 (0%)	5,605	45 (1%)	7,244	-13 (0%)	5,679	16 (0%)
Sep	5,086	47 (1%)	4,003	140 (3%)	5,322	52 (1%)	4,066	175 (4%)
Total (TAF)	3,020	19 (1%)	2,493	43 (2%)	3,265	24 (1%)	2,581	53 (2%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Nodes DEL_SWP_PAG and DEL_SWP_PMI)
Note:
Simulation period: 1922-2003. Change as measured from either existing condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.
(%) indicates percent change from either existing condition or No-Action Alternative
Key:
cfs = cubic feet per second
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation
SWP = State Water Project
TAF = thousand acre-feet

Impact H&H-12 (CP2): Change in Groundwater Levels CP2 would deliver additional surface water to CVP and SWP water contractors, reducing their need to pump groundwater. The reduction in groundwater pumping would result in increased groundwater levels. This impact would be beneficial.

With increased water supply deliveries to CVP and SWP water contractors, and with an associated increase in surface water supply reliability to those contractors, shortages in deliveries would decrease under CP2. Contractor responses to shortages in surface water deliveries would vary; some may elect to fallow their land, others may buy water on the transfer market, and some may pump groundwater. An increase in surface water deliveries would result in a decrease in groundwater pumping. With less groundwater pumping, groundwater basins that were in overdraft conditions would be anticipated to improve as a result of increasing groundwater levels. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-13 (CP2): Change in Groundwater Quality CP2 would deliver additional surface water to CVP and SWP water contractors, reducing their need to pump groundwater. This impact would be less than significant.

With increased water supply deliveries to CVP and SWP water contractors, and with an associated increase in surface water supply reliability to those contractors, shortages in deliveries would decrease under CP2. Contractor responses to shortages in surface water deliveries would vary; some may elect to fallow their land, others may buy water on the transfer market, and some may pump groundwater. An increase in surface water deliveries could result in a decrease in groundwater pumping. Because CP2 could have a positive, albeit limited, impact by reducing reliance on groundwater, the effects of CP2 on groundwater quality also would be limited. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CP3 – 18.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

CP3 primarily consists of raising Shasta Dam by 18.5 feet, which, in combination with spillway modifications, would increase the height of the reservoir's full pool by 20.5 feet and would enlarge the total storage capacity in the reservoir by 634,000 acre-feet. The existing TCD also would be extended to achieve efficient use of the expanded cold-water pool. Because CP3 would focus on increasing agricultural water supply reliability, none of the increased storage capacity in Shasta Reservoir would be reserved for increasing M&I deliveries.

Shasta Lake and Vicinity The significance criteria for H&H do not apply in the Shasta Lake and vicinity geographic region; therefore, potential effects in that geographic region are not discussed further in this EIS.

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact H&H-1 (CP3): Change in Frequency of Flows above 100,000 cfs on the Sacramento River below Bend Bridge Although flood management operations would not change under CP3, a slight reduction could occur in the frequency of flows greater than 100,000 cfs. This impact would be beneficial.

SLWRI modeling uses a monthly time step, which is inappropriate for flood control analysis; however, flood management operations for downstream objectives would not change under CP3. Although a slight decrease in recurrence of high flows would be possible because of the increased storage capability, CP3 would not increase the frequency of flows above 100,000 cfs. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-2 (CP3): Place Housing or Other Structures within a 100-Year Flood Hazard Area as Mapped on a Federal Flood Hazard Boundary or Flood Insurance Rate Map or Other Flood Hazard Delineation Map This impact would be the same as Impact H&H-2 (CP1); no new structures would be built downstream from Shasta Dam. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-3 (CP3): Place Within a 100-Year Flood Hazard Area Structures that Would Impede or Redirect Flood Flows This impact would be the same as Impact H&H-3 (CP1); no new structures would be built downstream from Shasta Dam. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta

Impact H&H-4 (CP3): Change in Water Levels in the Old River near Tracy Road Bridge Simulated water levels in the Old River near Tracy Road Bridge show very small reductions that would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant.

As shown in Table 6-50, maximum monthly reduction in minimum daily water level associated with CP3 would be less than 0.1 foot in all months during the irrigation season, compared to the existing condition and the No-Action Alternative. The water levels would remain above 0.0 feet elevation and would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-50. Simulated Monthly Maximum 15-Minute Change in Old River Water Levels near Tracy Road Bridge at Low-Low Tide

Month	Change from Existing Condition	Change from No-Action Alternative
	CP3 (2005) Change (feet)	CP3 (2030) Change (feet)
Apr	-0.01 (0%)	-0.02 (0%)
May	-0.02 (0%)	-0.02 (0%)
Jun	-0.05 (0%)	-0.05 (0%)
Jul	-0.02 (0%)	-0.03 (0%)
Aug	-0.02 (0%)	-0.05 (0%)
Sep	-0.10 (0%)	-0.07 (0%)
Oct	-0.06 (0%)	-0.05 (0%)

Source: Version 8.0.6 DSM2 2005 and 2030 simulations (Node 071_3116)

Notes:

Simulation period: 1922-2003

(%) indicates the percentage of months out of 82 years with a maximum decrease in water level exceeding 0.1 feet.

Key:

CP = comprehensive plan

Impact H&H-5 (CP3): Change in Water Levels in the Grant Line Canal near the Grant Line Canal Barrier Similar to Impact H&H-5 (CP1), CP3 would have the potential to affect water levels in the Grant Line Canal above the Grant Line Canal Barrier. This impact would be less than significant.

As shown in Table 6-51, maximum monthly changes in minimum daily water level associated with CP3 would be less than 0.1 foot in all months during the irrigation season, compared to the existing condition. Similarly, when compared to the No-Action Alternative, maximum monthly changes would be less than 0.1 foot in all months during the irrigation season.

Table 6-51 also shows the percentage of months when the maximum decreases in water levels are greater than 0.1 feet when the water levels under the baseline conditions are below the identified limit of 0.3 feet in the Grant Line Canal near the Grant Line Canal Barrier. These maximum decreases in water lever would not violate the threshold and would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-51. Simulated Monthly Maximum 15-Minute Change in Grant Line Canal Water Levels near the Grant Line Canal Barrier at Low-Low Tide

Month	Change from Existing Condition	Change from No-Action Alternative
	CP3 (2005) Change (feet)	CP3 (2030) Change (feet)
Apr	0 00 (0%)	-0.02 (0%)
May	-0.02 (0%)	-0.02 (0%)
Jun	-0.04 (0%)	-0.03 (0%)
Jul	-0.02 (0%)	-0.03 (0%)
Aug	-0.01 (0%)	-0.03 (0%)
Sep	-0.04 (0%)	-0.04 (0%)
Oct	-0.03 (0%)	-0.02 (0%)

Source: Version 8.0.6 DSM2 2005 and 2030 simulations (Node 129_5691)

Notes:
Simulation period: 1922-2003
(%) indicates the percentage of months out of 82 years with a maximum decrease in water level exceeding 0.1 feet.
Key:
CP = comprehensive plan

Impact H&H-6 (CP3): Change in Water Levels in the Middle River near the Howard Road Bridge This impact is similar to Impact H&H-6 (CP1). During the agricultural season (April through October), the maximum change in water level at low-low tide compared to the existing condition would exceed 0.1 foot in one month, September 1986. This impact would be less than significant.

As shown in Table 6-52, when compared to the No-Action Alternative, maximum monthly changes would be less than 0.1 foot in all months during the irrigation season. Table 6-52 also shows the percentage of months when the maximum decreases in water levels would be greater than 0.1 feet when the water levels under the baseline conditions were below the identified limit of 0.3 feet in the Middle River near the Howard Road Bridge. These maximum decreases in water lever would not violate the threshold and would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-52. Simulated Monthly Maximum 15-Minute Change in Middle River Water Levels near the Howard Road Bridge at Low-Low Tide

Month	Change from Existing Condition	Change from No-Action Alternative
	CP3 (2005) Change (feet)	CP3 (2030) Change (feet)
Apr	-0.01 (0%)	-0.02 (0%)
May	-0.02 (0%)	-0.02 (0%)
Jun	-0.05 (0%)	-0.05 (0%)
Jul	-0.02 (0%)	-0.03 (0%)
Aug	-0.02 (0%)	-0.04 (0%)
Sep	-0.11 (0%)	-0.07 (0%)
Oct	-0.07 (0%)	-0.05 (0%)

Source: Version 8.0.6 DSM2 2005 and 2030 simulations (Node 206_5533)

Notes:
Simulation period: 1922-2003
(%) indicates the percentage of months out of 82 years with a maximum decrease in water level exceeding 0.1 feet.
Key:
CP = comprehensive plan

Impact H&H-7 (CP3): Change in X2 Position The X2 position would change from west to east of Collinsville in one December, compared with existing conditions and the No-Action Alternative, when the Delta would not be in balanced conditions. This impact would be less than significant.

Examination of simulation output indicates that compared to the existing condition, only in one month, December 1979, would the X2 position shift from west to east of Collinsville. Under existing conditions, the X2 position would be at 78.25 km, and under CP3, it would be at 81.37 km, a 3.12 km shift.

Compared with the No-Action Alternative, only in one month, December 1979, would the X2 position change from west to east of Collinsville. Under the No-Action Alternative, the X2 position would be at 78.63 km, and under CP3, it would be at 81.08 km, a 2.45 km shift.

This single month change would not substantially limit CCWD's ability to fill Los Vaqueros Reservoir. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-8 (CP3): Change in Recurrence of Delta Excess Condition
Under CP3, changes from excess to balanced Delta conditions would be rare. This impact would be less than significant.

As shown in Table 6-53, CP3 would cause few changes from excess to balanced Delta conditions when compared to the existing condition and to the No-Action Alternative. Because of the low number of occurrences, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-53. Simulated Number of Years the Delta Changes from Excess to Balanced Condition

	Number of Years the Delta Changes from Excess to Balanced Conditions Compared to Existing Condition or No-Action Alternative											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CP3 (2005)	1 (1%)	0 (0%)	1 (1%)	0 (0%)	0 (0%)	0 (0%)	2 (2%)	2 (2%)	0 (0%)	0 (0%)	1 (1%)	1 (1%)
CP3 (2030)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	4 (5%)	1 (1%)	0 (0%)	2 (2%)	2 (2%)	0 (0%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations
Notes:
Simulation Period: 1922-2003
(%) indicates percent of months Delta condition change occurs.
Key:
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation

CVP/SWP Service Areas

Impact H&H-9 (CP3): Change in Deliveries to North-of-Delta CVP Water Service Contractors and Refuges Average annual deliveries to North-of-Delta CVP Water Service Contractors would increase under all conditions. This impact would be beneficial. Annual average deliveries to North-of-Delta refuges would not change under all conditions. This impact would be less than significant.

As shown in Table 6-54, average annual deliveries to North-of-Delta CVP Water Service Contractors under both existing and future conditions would increase relative to the basis of comparison. This impact is less than significant. Mitigation for this impact is not needed, and thus not proposed. Average annual deliveries to North-of-Delta refuges would not change under all conditions. Minor increases and decreases in Refuge deliveries are not a true representation of real-time operations but an indication of modeling artifacts. Such reduction would not occur in real time due to efficient water allocation and management schemes that cannot be captured adequately in a water resources planning model such as CalSim-II. This impact is less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-54. Simulated Monthly Average Deliveries and Percent Change of Deliveries to North-of-Delta CVP Water Service Contractors and Refuges

Month	Existing Condition (2005)				Future Condition (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (cfs)	CP3 Change (cfs (%))	Existing Condition (cfs)	CP3 Change (cfs (%))	No-Action Alternative (cfs)	CP3 Change (cfs (%))	No-Action Alternative (cfs)	CP3 Change (cfs (%))
North-of-Delta CVP Water Service Contractors Deliveries								
Oct	77	8 (11%)	69	9 (13%)	74	9 (12%)	63	10 (16%)
Nov	3	0 (11%)	3	1 (16%)	2	0 (12%)	3	1 (21%)
Dec	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
Jan	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
Feb	3	0 (4%)	7	0 (2%)	2	0 (5%)	5	0 (1%)
Mar	19	5 (24%)	21	7 (33%)	15	5 (32%)	14	7 (53%)
Apr	335	44 (13%)	229	53 (23%)	297	47 (16%)	181	57 (31%)
May	572	60 (10%)	316	69 (22%)	555	68 (12%)	268	75 (28%)
Jun	799	76 (10%)	425	90 (21%)	788	86 (11%)	365	95 (26%)
Jul	918	86 (9%)	480	101 (21%)	910	97 (11%)	414	108 (26%)
Aug	733	68 (9%)	386	81 (21%)	727	77 (11%)	333	87 (26%)
Sep	341	30 (9%)	170	36 (21%)	334	34 (10%)	144	39 (27%)
Total (TAF)	231	23 (10%)	128	27 (21%)	225	26 (11%)	109	29 (27%)
North-of-Delta Refuges Deliveries								
Oct	177	-7 (-4%)	182	-13 (-7%)	224	9 (4%)	212	30 (14%)
Nov	168	1 (0%)	156	3 (2%)	219	0 (0%)	212	-4 (-2%)
Dec	105	0 (0%)	104	0 (0%)	133	0 (0%)	132	0 (0%)
Jan	50	0 (0%)	50	0 (0%)	63	0 (0%)	62	0 (0%)
Feb	45	0 (0%)	45	0 (0%)	57	0 (0%)	57	0 (0%)
Mar	13	0 (0%)	12	0 (-1%)	16	0 (0%)	15	0 (-1%)
Apr	15	0 (0%)	14	0 (1%)	18	0 (-1%)	17	0 (-2%)
May	50	0 (0%)	46	0 (0%)	64	0 (0%)	59	0 (0%)
Jun	79	-1 (-1%)	75	-2 (-3%)	96	1 (1%)	87	4 (5%)
Jul	106	-1 (-1%)	99	-1 (-1%)	134	-1 (-1%)	126	-2 (-2%)
Aug	143	-2 (-1%)	134	-5 (-3%)	180	1 (1%)	165	3 (2%)
Sep	187	0 (0%)	177	0 (0%)	237	0 (0%)	226	0 (0%)
Total (TAF)	69	-1 (-1%)	66	-1 (-2%)	87	1 (1%)	83	2 (2%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Nodes DEL_CVP_PAG_N and DEL_CVP_PRF_N)

Notes:

Simulation period: 1922-2003. Change as measured from either existing condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

(%) indicates percent change from either existing condition or No-Action Alternative

Key:

cfs = cubic feet per second

CP = comprehensive plan

CVP = Central Valley Project

SLWRI = Shasta Lake Water Resources Investigation

TAF = thousand acre-feet

Impact H&H-10 (CP3): Change in Deliveries to South-of-Delta CVP Water Service Contractors and Refuges Average annual deliveries to South-of-Delta CVP Water Service Contractors would increase under all conditions. This impact would be beneficial. Annual average deliveries to South-of-Delta refuges would not change under all conditions. This impact would be less than significant.

As shown in Table 6-55, average annual deliveries to South-of-Delta Water Service Contractors under both existing and future conditions would increase relative to the basis of comparison. This impact is less than significant. Mitigation for this impact is not needed, and thus not proposed. Average annual deliveries to South-of-Delta refuges would not change under all conditions. Minor increases and decreases in Refuge deliveries are not a true representation of real-time operations but an indication of modeling artifacts. Such reduction would not occur in real time due to efficient water allocation and management schemes that cannot be captured adequately in a water resources planning model such as CalSim-II. This impact is less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-55. Simulated Monthly Average Deliveries and Percent Change of Deliveries to South-of-Delta CVP Water Service Contractors and Refuges

Month	Existing Condition (2005)				Future Condition (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (cfs)	CP3 Change (cfs (%))	Existing Condition (cfs)	CP3 Change (cfs (%))	No-Action Alternative (cfs)	CP3 Change (cfs (%))	No-Action Alternative (cfs)	CP3 Change (cfs (%))
South-of-Delta CVP Water Service Contractors Deliveries								
Oct	474	10 (2%)	363	15 (4%)	464	19 (4%)	343	27 (8%)
Nov	362	8 (2%)	277	12 (4%)	354	15 (4%)	262	21 (8%)
Dec	501	10 (2%)	383	16 (4%)	490	20 (4%)	362	29 (8%)
Jan	880	18 (2%)	673	29 (4%)	860	35 (4%)	636	51 (8%)
Feb	1,100	23 (2%)	841	36 (4%)	1,076	44 (4%)	794	63 (8%)
Mar	660	35 (5%)	362	26 (7%)	634	49 (8%)	302	53 (18%)
Apr	1,079	31 (3%)	627	2 (0%)	1,052	54 (5%)	545	51 (9%)
May	1,564	32 (2%)	902	2 (0%)	1,528	63 (4%)	794	72 (9%)
Jun	2,596	64 (2%)	1,467	30 (2%)	2,545	106 (4%)	1,310	122 (9%)
Jul	3,136	65 (2%)	1,809	0 (0%)	3,063	114 (4%)	1,581	109 (7%)
Aug	2,078	62 (3%)	1,112	48 (4%)	2,063	89 (4%)	939	163 (17%)
Sep	735	9 (1%)	428	-5 (-1%)	722	30 (4%)	370	35 (10%)
Total (TAF)	916	22 (2%)	558	13 (2%)	898	39 (4%)	497	48 (10%)

Table 6-55. Simulated Monthly Average Deliveries and Percent Change of Deliveries to South-of-Delta CVP Water Service Contractors and Refuges (contd.)

Month	Existing Condition (2005)				Future Condition (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (cfs)	CP3 Change (cfs (%))	Existing Condition (cfs)	CP3 Change (cfs (%))	No-Action Alternative (cfs)	CP3 Change (cfs (%))	No-Action Alternative (cfs)	CP3 Change (cfs (%))
South-of-Delta Refuges Deliveries								
Oct	1,126	0 (0%)	1,110	0 (0%)	1,041	0 (0%)	1,026	0 (0%)
Nov	729	0 (0%)	718	0 (0%)	671	0 (0%)	661	0 (0%)
Dec	336	0 (0%)	331	0 (0%)	306	0 (0%)	302	0 (0%)
Jan	147	0 (0%)	145	0 (0%)	137	0 (0%)	135	0 (0%)
Feb	109	0 (0%)	107	0 (0%)	102	0 (0%)	101	0 (0%)
Mar	93	0 (0%)	89	0 (0%)	88	0 (0%)	83	0 (0%)
Apr	217	0 (0%)	207	0 (0%)	203	0 (0%)	193	0 (0%)
May	445	0 (0%)	423	0 (0%)	407	0 (0%)	387	0 (0%)
Jun	493	0 (0%)	468	1 (0%)	456	0 (0%)	434	0 (0%)
Jul	120	0 (0%)	114	0 (0%)	112	0 (0%)	107	0 (0%)
Aug	197	2 (1%)	185	3 (1%)	181	5 (3%)	161	13 (8%)
Sep	885	-11 (-1%)	843	-11 (-1%)	808	1 (0%)	760	2 (0%)
Total (TAF)	296	-1 (0%)	286	0 (0%)	273	0 (0%)	263	1 (0%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Nodes DEL_CVP_PAG_S and DEL_CVP_PRF_S)
Notes:
Simulation period: 1922-2003.
(%) indicates percent change from either existing condition or No-Action Alternative Dry and critical years as defined by the Sacramento Valley Index.
Key:
cfs = cubic feet per second
CP = comprehensive plan
CVP = Central Valley Project
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre-feet

Impact H&H-11 (CP3): Change in Deliveries to SWP Table A Contractors
Average annual and monthly deliveries would decrease under both existing and future conditions. This decrease would be larger than what would occur under other action alternatives because no storage space would be reserved for increasing M&I deliveries under CP3. Accordingly, SWP deliveries were affected. This decrease would be less than 5 percent. This impact would be less than significant.

As shown in Table 6-56, average annual deliveries to SWP Table A contractors would decrease under CP3 in both existing and future conditions relative to the bases of comparison in both average years and in dry and critical years. Under both existing conditions and future conditions, the average monthly deliveries would decrease less than 5 percent in most months in both average annual and dry and critical years. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-56. Simulated Monthly Average Deliveries and Percent Change of Deliveries to SWP Table A Contractors

Month	Existing Condition (2005)				Future Condition (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (cfs)	CP3 Change (cfs (%))	Existing Condition (cfs)	CP3 Change (cfs (%))	No-Action Alternative (cfs)	CP3 Change (cfs (%))	No-Action Alternative (cfs)	CP3 Change (cfs (%))
Oct	3,226	-25 (-1%)	2,873	8 (0%)	3,351	-9 (0%)	3,051	-13 (0%)
Nov	2,689	4 (0%)	2,282	6 (0%)	2,812	1 (0%)	2,342	1 (0%)
Dec	2,476	4 (0%)	2,014	12 (1%)	2,886	-1 (0%)	2,392	38 (2%)
Jan	623	-6 (-1%)	389	-5 (-1%)	988	-20 (-2%)	412	-18 (-4%)
Feb	1,106	-6 (-1%)	637	-10 (-2%)	1,860	-13 (-1%)	766	-25 (-3%)
Mar	1,804	-6 (0%)	1,041	-14 (-1%)	2,307	-9 (0%)	1,101	-31 (-3%)
Apr	4,733	1 (0%)	4,156	-9 (0%)	5,094	2 (0%)	4,251	-25 (-1%)
May	5,837	17 (0%)	4,983	-14 (0%)	6,335	5 (0%)	5,143	-22 (0%)
Jun	7,433	22 (0%)	6,408	-11 (0%)	7,612	-8 (0%)	6,471	-87 (-1%)
Jul	7,841	-6 (0%)	6,757	-9 (0%)	8,147	-31 (0%)	6,933	-56 (-1%)
Aug	7,017	-25 (0%)	5,605	-58 (-1%)	7,244	-54 (-1%)	5,679	-132 (-2%)
Sep	5,086	-4 (0%)	4,003	-8 (0%)	5,322	4 (0%)	4,066	3 (0%)
Total (TAF)	3,020	-2 (0%)	2,493	-7 (0%)	3,265	-8 (0%)	2,581	-22 (-1%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Nodes DEL_SWP_PAG and DEL_SWP_PMI)

Notes:

Simulation period: 1922-2003.

(%) indicates percent change from either existing condition or No-Action Alternative Dry and critical years as defined by the Sacramento Valley Index.

Key:

cfs = cubic feet per second

CP = comprehensive plan

SLWRI = Shasta Lake Water Resources Investigation

SWP = State Water Project

TAF = thousand acre-feet

Impact H&H-12 (CP3): Change in Groundwater Levels CP3 would deliver additional surface water to CVP and SWP water contractors, reducing their need to pump groundwater. The reduction in groundwater pumping would result in increased groundwater levels. This impact would be beneficial.

With increased water supply deliveries to CVP and SWP water contractors, and with an associated increase in surface water supply reliability to those contractors, shortages in deliveries would decrease under CP3. Contractor responses to shortages in surface water deliveries would vary; some may elect to fallow their land, others may buy water on the transfer market, and some may pump groundwater. An increase in surface water deliveries would result in a decrease in groundwater pumping. With less groundwater pumping, groundwater basins that were in overdraft conditions would be anticipated to improve as a result of increasing groundwater levels. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-13 (CP3): Change in Groundwater Quality CP3 would deliver additional surface water to CVP and SWP water contractors, reducing their need to pump groundwater. The reduction in groundwater pumping could improve groundwater quality. This impact would less than significant.

With increased water supply deliveries to CVP and SWP water contractors, and with an associated increase in surface water supply reliability to those contractors, shortages in deliveries would decrease under CP3. Contractor responses to shortages in surface water deliveries would vary; some may elect to fallow their land, others may buy water on the transfer market, and some may pump groundwater. An increase in surface water deliveries would result in a decrease in groundwater pumping. Because CP3 would have a positive, albeit limited, impact by reducing reliance on groundwater, the effects of CP3 on groundwater quality also would be limited. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CP4 and CP4A– 18.5-Foot Dam Raise, Anadromous Fish Focus With Water Supply Reliability

CP4 and CP4A focus on increasing anadromous fish survival while also increasing water supply reliability. By raising Shasta Dam 18.5 feet, in combination with spillway modifications, CP4 or CP4A would increase the height of the reservoir full pool by 20.5 feet and would enlarge the total storage capacity in the reservoir by 634,000 acre-feet. The existing TCD also would be extended to achieve efficient use of the expanded cold-water pool.

For CP4, about 378,000 acre-feet of the increased reservoir storage space would be dedicated to increasing the supply of cold water for anadromous fish survival purposes. Operations for the remaining portion of increased storage (approximately 256,000 acre-feet) would be the same as under CP1, with 70,000 acre-feet and 35,000 acre-feet reserved to specifically focus on increasing M&I deliveries during dry and critical years, respectively. Because CP4 would increase the active or useable storage in Shasta Reservoir by the same amount as under CP1, and the storage would be used under the same operational rules, releases from Shasta would be the same as under CP1.

For CP4A, about 191,000 acre-feet of the increased reservoir storage space would be dedicated to increasing the supply of cold water for anadromous fish survival purposes. Operations for the remaining portion of increased storage (approximately 443,000 acre-feet) would be the same as under CP2, when in dry years and critical years, 120,000 acre-feet and 60,000 acre-feet, respectively, of the increased storage capacity in Shasta Reservoir would be reserved to specifically focus on increasing M&I deliveries. Because CP4A would increase the active or usable storage in Shasta Reservoir by the same amount as under CP2, and the storage would be used under the same operational rules, releases from Shasta would be the same as under CP2.

For CP4 or CP4A, the additional storage that would be dedicated to increasing the supply of cold water, or the cold-water pool, would result in different Shasta storages, elevations, and release temperatures but not in any other downstream water operations.

Shasta Lake and Vicinity The significance criteria for H&H do not apply in the Shasta Lake and vicinity geographic region; therefore, potential effects in that geographic region are not discussed further in this EIS.

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact H&H-1 (CP4 and CP4A). Change in Frequency of Flows above 100,000 cfs on the Sacramento River below Bend Bridge For CP4, this impact would be the same as Impact H&H-1 (CP1). Although flood management operations would not change under CP4, a slight reduction could occur in the frequency of flows greater than 100,000 cfs. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, this impact would be the same as Impact H&H-1 (CP2). Although flood management operations would not change under CP4A, a slight reduction could occur in the frequency of flows greater than 100,000 cfs. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-2 (CP4 and CP4A). Place Housing or Other Structures within a 100-Year Flood Hazard Area as Mapped on a Federal Flood Hazard Boundary or Flood Insurance Rate Map or Other Flood Hazard Delineation Map For CP4, this impact would be the same as Impact H&H-2 (CP1). No new structures would be built downstream from Shasta Dam. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, this impact would be the same as H&H-2 (CP2), which is the same as Impact H&H-2 (CP1); no new structures would be built downstream from Shasta Dam. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-3 (CP4 and CP4A). Place Within a 100-Year Flood Hazard Area Structures that Would Impede or Redirect Flood Flows For CP4, this impact would be the same as Impact H&H-3 (CP1). No new structures would be built downstream from Shasta Dam. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, this impact would be the same as Impact H&H-3 (CP2), which is the same as Impact H&H-3 (CP1); no new structures would be built downstream from Shasta Dam. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta

Impact H&H-4 (CP4 and CP4A). Change in Water Levels in Old River near Tracy Road Bridge For CP4, this impact would be the same as Impact H&H-4 (CP1). Simulated water levels in the Old River near Tracy show very small reductions that would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, this impact would be the same as Impact H&H-4 (CP2). Simulated water levels in the Old River near Tracy Road Bridge show very small reductions that would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-5 (CP4 and CP4A). Change in Water Levels in the Grant Line Canal near the Grant Line Canal Barrier For CP4, this impact would be the same as Impact H&H-5 (CP1). Simulated water levels in the Grant Line Canal near the Grant Line Canal Barrier show very small reductions that would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, this impact would be the same as Impact H&H-5 (CP2). Simulated water levels in the Grant Line Canal near the Grant Line Canal Barrier show very small reductions that would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-6 (CP4 and CP4A). Change in Water Levels in Middle River near the Howard Road Bridge For CP4, this impact would be the same as Impact H&H-6 (CP1). Simulated water levels in the Middle River near the Howard Road Bridge show very small reductions that would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, this impact would be the same as Impact H&H-6 (CP2). Simulated water levels in the Middle River near the Howard Road Bridge show very small reductions that would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-7 (CP4 and CP4A): Change in X2 Position For CP4, this impact would be the same as Impact H&H-7 (CP1). The X2 position would not change from west to east of Collinsville in December or January, when the Delta would not be in balanced conditions. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, this impact would be the same as Impact H&H-7 (CP2). The X2 position would change from west to east of Collinsville in one December compared to the existing conditions, when the Delta would not be in balanced conditions. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-8 (CP4 and CP4A): Change in Recurrence of Delta Excess Conditions For CP4, this impact would be the same as Impact H&H-8 (CP1); changes from excess to balanced Delta conditions would be rare. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, this impact would be the same as Impact H&H-8 (CP2). Changes from excess to balanced Delta conditions would be rare. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CVP/SWP Service Areas

Impact H&H-9 (CP4 and CP4A): Change in Deliveries to North-of-Delta CVP Water Service Contractors and Refuges For CP4, this impact would be the same as Impact H&H-9 (CP1). Average annual and monthly deliveries to North-of-Delta CVP water service contractors would increase under both existing and future conditions, but some small decreases could occur in monthly deliveries under both existing and future conditions. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed. Average annual deliveries to North-of-Delta refuges would not change under all conditions. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, this impact would be the same as Impact H&H-9 (CP2). Average annual deliveries to North-of-Delta CVP water service contractors would increase under all conditions. Average monthly deliveries would generally increase but could show small decreases in October and November of less than the significance criteria. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed. Average annual deliveries to North-of-Delta refuges would not change under all conditions. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-10 (CP4 and CP4A): Change in Deliveries to South-of-Delta CVP Water Service Contractors and Refuges For CP4, this impact would be the same as Impact H&H-10 (CP1). Average annual and monthly deliveries would increase under both existing and future conditions. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, this impact would be the same as Impact H&H-10 (CP2), which is similar to Impact H&H-10 (CP1). Average annual and monthly deliveries would increase under both existing and future conditions, except the increase in deliveries would be greater under CP2. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-11 (CP4 and CP4A): Change in Deliveries to SWP Table A Contractors For CP4, this impact would be the same as Impact H&H-11 (CP1). Average annual deliveries would increase under both existing and future conditions, but some less than significant decreases could occur in monthly deliveries under future conditions. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, this impact would be the same as Impact H&H-11 (CP2). Average annual and monthly deliveries would increase under both existing and future conditions. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-12 (CP4 and CP4A). Change in Groundwater Levels For CP4, this impact would be the same as Impact H&H-12 (CP1). CP4 would deliver additional surface water to CVP and SWP water contractors, reducing their need to pump groundwater. The reduction in groundwater pumping would result in increased groundwater levels. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, this impact would be the same as Impact H&H-12 (CP2). CP4A would deliver additional surface water to CVP and SWP water contractors, reducing their need to pump groundwater. The reduction in groundwater pumping would result in increased groundwater levels. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-13 (CP4 and CP4A). Change in Groundwater Quality For CP4, this impact would be the same as Impact H&H-13 (CP1). CP4 would deliver additional surface water to CVP and SWP water contractors, reducing their need to pump groundwater. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, this impact would be the same as Impact H&H-13 (CP2). CP4A would deliver additional surface water to CVP and SWP water contractors, reducing their need to pump groundwater. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CP5 – 18.5-Foot Dam Raise, Combination Plan

CP5 primarily would consist of raising Shasta Dam by 18.5 feet, which, in combination with spillway modifications, would increase the height of the reservoir’s full pool by 20.5 feet and would enlarge the total storage capacity in the reservoir by 634,000 acre-feet. The existing TCD also would be extended to achieve efficient use of the expanded cold-water pool. Shasta Dam operational guidelines would continue essentially unchanged, except during dry years and critical years, when 150,000 acre-feet and 75,000 acre-feet, respectively, of the increased storage capacity in Shasta Reservoir would be reserved to specifically focus on increasing M&I deliveries.

Shasta Lake and Vicinity The significance criteria for H&H do not apply in the Shasta Lake and vicinity geographic region; therefore, potential effects in that geographic region are not discussed further in this EIS.

Upper Sacramento River (Shasta Dam to Red Bluff)
Impact H&H-1 (CP5): Change in Frequency of Flows above 100,000 cfs on the Sacramento River below Bend Bridge Although flood management operations would not change under CP5, a slight reduction could occur in the frequency of flows greater than 100,000 cfs. This impact would be beneficial.

SLWRI modeling uses a monthly time step, which is inappropriate for flood control analysis; however, flood management operations for downstream objectives would not change under CP5. Although a slight decrease in recurrence of high flows would be possible because of the increased storage capability, CP5 would not increase the frequency of flows above 100,000 cfs. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-2 (CP5): Place Housing or Other Structures within a 100-Year Flood Hazard Area as Mapped on a Federal Flood Hazard Boundary or Flood Insurance Rate Map or Other Flood Hazard Delineation Map This impact would be the same as Impact H&H-2 (CP1). No new structures would be built downstream from Shasta Dam. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-3 (CP5): Place within a 100-Year Flood Hazard Area Structures that Would Impede or Redirect Flood Flows This impact would be the same as Impact H&H-3 (CP1). No new structures would be built downstream from Shasta Dam. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta
Impact H&H-4 (CP5): Change in Water Levels in Old River near Tracy Road Bridge Simulated water levels in the Old River near Tracy Road Bridge show very small reductions that would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant.

As shown in Table 6-57, maximum monthly reduction in minimum daily water level associated with CP5 would be less than 0.1 foot in all months during the irrigation season, compared to the existing condition and the No-Action Alternative. The water levels would remain above 0.0 feet elevation and would not adversely affect agricultural users' ability to divert irrigation water. This

impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-57. Simulated Monthly Maximum 15-Minute Change in Old River Water Levels near Tracy Road Bridge at Low-Low Tide

Month	Change from Existing Condition	Change from No-Action Alternative
	CP5 (2005) Change (feet)	CP5 (2030) Change (feet)
Apr	-0.01 (0%)	-0.02 (0%)
May	-0.02 (0%)	-0.02 (0%)
Jun	-0.05 (0%)	-0.05 (0%)
Jul	-0.06 (0%)	-0.09 (0%)
Aug	-0.07 (0%)	-0.08 (0%)
Sep	-0.07 (0%)	-0.08 (0%)
Oct	-0.07 (0%)	-0.06 (0%)

Source: Version 8.0.6 DSM2 2005 and 2030 simulations (Node 071_3116)
Notes:
Simulation period: 1922-2003
(%) indicates the percentage of months out of 82 years with a maximum decrease in water level exceeding 0.1 feet.
Key:
CP = comprehensive plan

Impact H&H-5 (CP5): Change in Water Levels in the Grant Line Canal near the Grant Line Canal Barrier Simulated water levels in the Old River near Tracy show very small reductions that would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant.

As shown in Table 6-58, maximum monthly reduction in minimum daily water level associated with CP5 would be less than 0.1 foot in all months during the irrigation season, compared to the existing condition and the No-Action Alternative. The water levels would remain above 0.0 feet elevation and would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-58. Simulated Monthly Maximum 15-Minute Change in Grant Line Canal Water Levels near the Grant Line Canal Barrier at Low-Low Tide

Month	Change from Existing Condition	Change from No-Action Alternative
	CP5 (2005) Change (feet)	CP5 (2030) Change (feet)
Apr	0.00 (0%)	-0.02 (0%)
May	-0.02 (0%)	-0.02 (0%)
Jun	-0.04 (0%)	-0.03 (0%)
Jul	-0.07 (0%)	-0.08 (0%)
Aug	-0.05 (0%)	-0.05 (0%)
Sep	-0.03 (0%)	-0.05 (0%)
Oct	-0.03 (0%)	-0.03 (0%)

Source: Version 8.0.6 DSM2 2005 and 2030 simulations (Node 129_5691)

Notes:
Simulation period: 1922-2003
(%) indicates the percentage of months out of 82 years with a maximum decrease in water level exceeding 0.1 feet.
Key:
CP = comprehensive plan

Impact H&H-6 (CP5): Change in Water Levels in the Middle River near the Howard Road Bridge Simulated water levels in the Middle River near the Howard Road Bridge show very small reductions that would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant.

As shown in Table 6-59, maximum monthly reduction in minimum daily water level associated with CP5 would be less than 0.1 foot in all months during the irrigation season, compared to the existing condition and the No-Action Alternative. The water levels would remain above 0.3 feet elevation and would not adversely affect agricultural users' ability to divert irrigation water. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-59. Simulated Monthly Maximum 15-Minute Change in Middle River Water Levels near the Howard Road Bridge at Low-Low Tide

Month	Change from Existing Condition	Change from No-Action Alternative
	CP5 (2005) Change (feet)	CP5 (2030) Change (feet)
Apr	-0.01 (0%)	-0.02 (0%)
May	-0.02 (0%)	-0.02 (0%)
Jun	-0.05 (0%)	-0.05 (0%)
Jul	-0.06 (0%)	-0.08 (0%)
Aug	-0.07 (0%)	-0.08 (0%)
Sep	-0.07 (0%)	-0.09 (0%)
Oct	-0.08 (0%)	-0.07 (0%)

Source: Version 8.0.6 DSM2 2005 and 2030 simulations (Node 206_5533)

Notes:
Simulation period: 1922-2003
(%) indicates the percentage of months out of 82 years with a maximum decrease in water level exceeding 0.1 feet.
Key:
CP = comprehensive plan

Impact H&H-7 (CP5): Change in X2 Position The X2 position would change from west to east of Collinsville in one December, compared with existing conditions and the No-Action Alternative when the Delta would not be in balanced conditions. This impact would be less than significant.

Examination of simulation output indicates that compared to the existing condition, only in one month, December 1979, would the X2 position shift from west to east of Collinsville. Under existing conditions, the X2 position would be at 78.25 km, and under CP5, it would be at 81.36 km, a 3.11 km shift. Compared to the No-Action Alternative, only in one month, December 1979, would the X2 position change from west to east of Collinsville. Under the No-Action Alternative, the X2 position would be at 78.63 km, and under CP5, it would be at 81.08 km, a 2.45 km shift. This single month change would not significantly limit CCWD’s ability to fill Los Vaqueros Reservoir. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-8 (CP5): Change in Recurrence of Delta Excess Condition Under CP5, changes from excess to balanced Delta conditions would be rare. This impact would be less than significant.

As shown in Table 6-60, CP5 would cause one March, one June, one August, one October, three Novembers, and one December to change from excess to balanced Delta conditions, when compared to the existing condition, and four Julys, one August, five Octobers , and three Novembers when compared to the No-Action Alternative. Because of the low number of occurrences, this impact

would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-60. Simulated Number of Years the Delta Changes from Excess to Balanced Condition

	Number of Years the Delta Changes from Excess to Balanced Conditions Compared to Existing Condition or No-Action Alternative											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
CP5 (2005)	0 (0%)	0 (0%)	1 (1%)	0 (0%)	0 (0%)	0 (0%)	1 (1%)	1 (1%)	0 (0%)	1 (1%)	3 (4%)	1 (1%)
CP5 (2030)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	4 (5%)	1 (1%)	0 (0%)	5 (6%)	3 (4%)	0 (0%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations
Notes:
Simulation Period: 1922-2003
(%) indicates percent of months Delta condition change occurs.
Key:
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation

CVP/SWP Service Areas

Impact H&H-9 (CP5): Change in Deliveries to North-of-Delta CVP Water Service Contractors and Refuges Average annual deliveries to North-of-Delta CVP Water Service Contractors would increase under all conditions. This impact would be beneficial. Annual average deliveries to North-of-Delta refuges would not change under all conditions. This impact would be less than significant.

As shown in Table 6-61, average annual deliveries to North-of-Delta Water Service Contractors under both existing and future conditions would increase relative to the basis of comparison. This impact is less than significant. Mitigation for this impact is not needed, and thus not proposed. Average annual deliveries to North-of-Delta refuges would not change under all conditions. Minor increases and decreases in Refuge deliveries are not true a representation of real-time operations but an indication of modeling artifacts. Such reduction would not occur in real time due to efficient water allocation and management schemes that cannot be captured adequately in a water resources planning model such as CalSim-II. This impact is less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-61. Simulated Monthly Average Deliveries and Percent Change of Deliveries to North-of-Delta CVP Water Service Contractors and Refuges

Month	Existing Condition (2005)				Future Condition (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (cfs)	CP5 Change (cfs (%))	Existing Condition (cfs)	CP5 Change (cfs (%))	No-Action Alternative (cfs)	CP5 Change (cfs (%))	No-Action Alternative (cfs)	CP5 Change (cfs (%))
North-of-Delta CVP Water Service Contractors Deliveries								
Oct	77	7 (9%)	69	6 (9%)	74	7 (10%)	63	7 (12%)
Nov	3	0 (8%)	3	0 (13%)	2	0 (9%)	3	0 (16%)
Dec	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
Jan	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
Feb	3	0 (3%)	7	0 (1%)	2	0 (4%)	5	0 (1%)
Mar	19	4 (18%)	21	5 (24%)	15	4 (24%)	14	5 (38%)
Apr	335	34 (10%)	229	42 (18%)	297	38 (13%)	181	43 (24%)
May	572	46 (8%)	316	52 (16%)	555	54 (10%)	268	55 (20%)
Jun	799	58 (7%)	425	68 (16%)	788	67 (8%)	365	69 (19%)
Jul	918	64 (7%)	480	76 (16%)	910	74 (8%)	414	77 (19%)
Aug	733	50 (7%)	386	61 (16%)	727	58 (8%)	333	62 (19%)
Sep	341	22 (7%)	170	27 (16%)	334	26 (8%)	144	27 (19%)
Total (TAF)	231	17 (8%)	128	21 (16%)	225	20 (9%)	109	21 (19%)
North-of-Delta Refuges Deliveries								
Oct	177	-10 (-6%)	182	-31 (-17%)	224	-4 (-2%)	212	-4 (-2%)
Nov	168	0 (0%)	156	4 (3%)	219	1 (1%)	212	0 (0%)
Dec	105	0 (0%)	104	0 (0%)	133	0 (0%)	132	0 (0%)
Jan	50	0 (0%)	50	0 (0%)	63	0 (0%)	62	0 (0%)
Feb	45	0 (0%)	45	0 (0%)	57	0 (0%)	57	0 (0%)
Mar	13	0 (0%)	12	0 (-1%)	16	0 (0%)	15	0 (1%)
Apr	15	0 (0%)	14	0 (0%)	18	0 (-1%)	17	0 (-2%)
May	50	0 (0%)	46	0 (0%)	64	0 (-1%)	59	-1 (-2%)
Jun	79	-1 (-1%)	75	-2 (-3%)	96	1 (1%)	87	3 (3%)
Jul	106	-1 (-1%)	99	-3 (-3%)	134	1 (1%)	126	2 (2%)
Aug	143	0 (0%)	134	0 (0%)	180	3 (2%)	165	9 (6%)
Sep	187	0 (0%)	177	0 (0%)	237	0 (0%)	226	0 (0%)
Total (TAF)	69	-1 (-1%)	66	-2 (-3%)	87	0 (0%)	83	1 (1%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Nodes DEL_CVP_PAG_N and DEL_CVP_PRF_N)

Note:

Simulation period: 1922-2003. Change as measured from either existing condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

(%) indicates percent change from either existing condition or No-Action Alternative

Key:

cfs = cubic feet per second

CP = comprehensive plan

CVP = Central Valley Project

SLWRI = Shasta Lake Water Resources Investigation

TAF = thousand acre-feet

Impact H&H-10 (CP5): Change in Deliveries to South-of-Delta CVP Water Service Contractors and Refuges Average annual deliveries to South-of-Delta CVP Water Service Contractors would increase under all conditions. This impact would be beneficial. Annual average deliveries to South-of-Delta refuges would not change under all conditions. This impact would be less than significant.

As shown in Table 6-62, average annual deliveries to South-of-Delta Water Service Contractors under both existing and future conditions would increase relative to the basis of comparison. This impact is less than significant. Mitigation for this impact is not needed, and thus not proposed. Average annual deliveries to South-of-Delta refuges would not change under all conditions. Minor increases and decreases in Refuge deliveries are not a true representation of real-time operations but an indication of modeling artifacts. Such reduction would not occur in real time due to efficient water allocation and management schemes that cannot be captured adequately in a water resources planning model such as CalSim-II. This impact is less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-62. Simulated Monthly Average Deliveries and Percent Change of Deliveries to South-of-Delta CVP Water Service Contractors and Refuges

Month	Existing Condition (2005)				Future Condition (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (cfs)	CP5 Change (cfs (%))	Existing Condition (cfs)	CP5 Change (cfs (%))	No-Action Alternative (cfs)	CP5 Change (cfs (%))	No-Action Alternative (cfs)	CP5 Change (cfs (%))
South-of-Delta CVP Water Service Contractors Deliveries								
Oct	474	6 (1%)	363	11 (3%)	464	13 (3%)	343	21 (6%)
Nov	362	4 (1%)	277	8 (3%)	354	10 (3%)	262	16 (6%)
Dec	501	6 (1%)	383	11 (3%)	490	13 (3%)	362	23 (6%)
Jan	880	11 (1%)	673	20 (3%)	860	23 (3%)	636	40 (6%)
Feb	1,100	13 (1%)	841	25 (3%)	1,076	29 (3%)	794	50 (6%)
Mar	660	22 (3%)	362	17 (5%)	634	35 (5%)	302	37 (12%)
Apr	1,079	20 (2%)	627	-9 (-1%)	1,052	38 (4%)	545	34 (6%)
May	1,564	18 (1%)	902	-11 (-1%)	1,528	41 (3%)	794	45 (6%)
Jun	2,596	37 (1%)	1,467	0 (0%)	2,545	69 (3%)	1,310	76 (6%)
Jul	3,136	34 (1%)	1,809	-30 (-2%)	3,063	71 (2%)	1,581	58 (4%)
Aug	2,078	19 (1%)	1,112	-34 (-3%)	2,063	40 (2%)	939	73 (8%)
Sep	735	5 (1%)	428	-6 (-1%)	722	22 (3%)	370	27 (7%)
Total (TAF)	916	12 (1%)	558	0 (0%)	898	24 (3%)	497	30 (6%)

Table 6-62. Simulated Monthly Average Deliveries and Percent Change of Deliveries to South-of-Delta CVP Water Service Contractors and Refuges (contd.)

Month	Existing Condition (2005)				Future Condition (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (cfs)	CP5 Change (cfs (%))	Existing Condition (cfs)	CP5 Change (cfs (%))	No-Action Alternative (cfs)	CP5 Change (cfs (%))	No-Action Alternative (cfs)	CP5 Change (cfs (%))
South-of-Delta Refuges Deliveries								
Oct	1,126	0 (0%)	1,110	0 (0%)	1,041	0 (0%)	1,026	0 (0%)
Nov	729	0 (0%)	718	0 (0%)	671	0 (0%)	661	0 (0%)
Dec	336	0 (0%)	331	0 (0%)	306	0 (0%)	302	0 (0%)
Jan	147	0 (0%)	145	0 (0%)	137	0 (0%)	135	0 (0%)
Feb	109	0 (0%)	107	0 (0%)	102	0 (0%)	101	0 (0%)
Mar	93	0 (0%)	89	0 (0%)	88	0 (0%)	83	0 (0%)
Apr	217	0 (0%)	207	0 (0%)	203	0 (0%)	193	0 (0%)
May	445	0 (0%)	423	0 (0%)	407	0 (0%)	387	0 (0%)
Jun	493	0 (0%)	468	0 (0%)	456	0 (0%)	434	0 (0%)
Jul	120	0 (0%)	114	0 (0%)	112	0 (0%)	107	-1 (-1%)
Aug	197	1 (0%)	185	1 (1%)	181	3 (2%)	161	9 (5%)
Sep	885	-7 (-1%)	843	0 (0%)	808	5 (1%)	760	13 (2%)
Total (TAF)	296	0 (0%)	286	0 (0%)	273	0 (0%)	263	1 (0%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Nodes DEL_CVP_PAG_S and DEL_CVP_PRF_S)

Notes:

Simulation period: 1922-2003.

(%) indicates percent change from either existing condition or No-Action Alternative Dry and critical years as defined by the Sacramento Valley Index.

Key:

cfs = cubic feet per second

CP = comprehensive plan

CVP = Central Valley Project

SLWRI = Shasta Lake Water Resources Investigation

TAF = thousand acre-feet

Impact H&H-11 (CP5): Change in Deliveries to SWP Table A Contractors
This impact would be similar to Impact H&H-11 (CP1), except the increase in average annual deliveries would be greater, and potential decreases in average monthly deliveries in some months could be slightly larger under CP5. This impact would be less than significant.

As shown in Table 6-63, average annual deliveries to SWP Table A contractors would increase under CP5, in both existing and future conditions relative to the bases of comparison in both average years and in dry and critical years. Some monthly average decreases around 1 percent could occur in deliveries relative to the No-Action Alternative under existing and future conditions in both average annual and dry and critical years. The average monthly deliveries would increase in all months under CP5 relative to the No-Action Alternative under future conditions. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 6-63. Simulated Monthly Average Deliveries and Percent Change of Deliveries to SWP Table A Contractors

Month	Existing Condition (2005)				Future Condition (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (cfs)	CP5 Change (cfs (%))	Existing Condition (cfs)	CP5 Change (cfs (%))	No-Action Alternative (cfs)	CP5 Change (cfs (%))	No-Action Alternative (cfs)	CP5 Change (cfs (%))
Oct	3,226	-8 (0%)	2,873	73 (3%)	3,351	57 (2%)	3,051	64 (2%)
Nov	2,689	79 (3%)	2,282	83 (4%)	2,812	32 (1%)	2,342	33 (1%)
Dec	2,476	19 (1%)	2,014	76 (4%)	2,886	49 (2%)	2,392	90 (4%)
Jan	623	22 (4%)	389	2 (1%)	988	55 (6%)	412	32 (8%)
Feb	1,106	36 (3%)	637	48 (8%)	1,860	59 (3%)	766	49 (6%)
Mar	1,804	27 (1%)	1,041	57 (5%)	2,307	30 (1%)	1,101	73 (7%)
Apr	4,733	17 (0%)	4,156	47 (1%)	5,094	40 (1%)	4,251	109 (3%)
May	5,837	47 (1%)	4,983	60 (1%)	6,335	36 (1%)	5,143	118 (2%)
Jun	7,433	7 (0%)	6,408	-24 (0%)	7,612	33 (0%)	6,471	44 (1%)
Jul	7,841	55 (1%)	6,757	166 (2%)	8,147	27 (0%)	6,933	126 (2%)
Aug	7,017	21 (0%)	5,605	80 (1%)	7,244	-20 (0%)	5,679	2 (0%)
Sep	5,086	54 (1%)	4,003	161 (4%)	5,322	71 (1%)	4,066	225 (6%)
Total (TAF)	3,020	23 (1%)	2,493	50 (2%)	3,265	28 (1%)	2,581	58 (2%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Nodes DEL_SWP_PAG and DEL_SWP_PMI)

Notes:

Simulation period: 1922-2003.

(%) indicates percent change from either existing condition or No-Action Alternative Dry and critical years as defined by the Sacramento Valley Index.

Key:

cfs = cubic feet per second

CP = comprehensive plan

SLWRI = Shasta Lake Water Resources Investigation

SWP = State Water Project

TAF = thousand acre-feet

Impact H&H-12 (CP5): Change in Groundwater Levels CP5 would deliver additional surface water to CVP and SWP water contractors, reducing their need to pump groundwater. The reduction in groundwater pumping would result in increased groundwater levels. This impact would be beneficial.

With increased water supply deliveries to CVP and SWP water contractors, and with an associated increase in surface water supply reliability to those contractors, shortages in deliveries would decrease under CP5. Contractor responses to shortages in surface water deliveries would vary; some may elect to fallow their land, others may buy water on the transfer market, and some may pump groundwater. An increase in surface water deliveries would result in a decrease in groundwater pumping. With less groundwater pumping, groundwater basins that were in overdraft conditions would be anticipated to improve as a result of increasing groundwater levels. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact H&H-13 (CP5): Change in Groundwater Quality CP5 would deliver additional surface water to CVP and SWP water contractors, reducing their need to pump groundwater. The reduction in groundwater pumping could improve groundwater quality. This impact would less than significant.

With increased water supply deliveries to CVP and SWP water contractors, and an associated increase in surface water supply reliability to those contractors, shortages in deliveries would decrease under CP5. Contractor responses to shortages in surface water deliveries would vary; some may elect to fallow their land, others may buy water on the transfer market, and some may pump groundwater. An increase in surface water deliveries would result in a decrease in groundwater pumping. Because CP5 would have a positive, albeit limited, impact by reducing reliance on groundwater, the effects of CP5 on groundwater quality also would be limited. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

6.3.4 Mitigation Measures

Table 6-64 presents a summary of mitigation measures for H&H. No potentially significant impacts have been identified, and therefore no mitigation measures are proposed.

No-Action Alternative

No mitigation measures are required for this alternative.

CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

No mitigation measures are required for this alternative.

CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

No mitigation measures are required for this alternative.

CP3 – 18.5-Foot Dam Raise, Agricultural Water Supply Reliability and Anadromous Fish Survival

No mitigation measures are required for this alternative.

CP4 and CP4A – 18.5-Foot Dam Raise, Anadromous Fish Focus with Water Supply Reliability

No mitigation measures are required for CP4 or CP4A.

CP5 – 18.5-Foot Dam Raise, Combination Plan

No mitigation measures are required for this alternative.

Table 6-64. Summary of Mitigation Measures for Hydrology, Hydraulics, and Water Management

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/CP4A	CP5
Impact H&H-1: Change in Frequency of Flows above 100,000 cfs on the Sacramento River below Bend Bridge	LOS before Mitigation	NI	B	B	B	B	B
	Mitigation Measure	None required.	No mitigation needed; thus, none proposed.				
	LOS after Mitigation	NI	B	B	B	B	B
Impact H&H-2: Place Housing or Other Structures within a 100-Year Flood Hazard Area as Mapped on a Federal Flood Hazard Boundary or Flood Insurance Rate Map or Other Flood Hazard Delineation Map	LOS before Mitigation	NI	NI	NI	NI	NI	NI
	Mitigation Measure	None required.	No mitigation needed; thus, none proposed.				
	LOS after Mitigation	NI	NI	NI	NI	NI	NI
Impact H&H-3: Place within a 100-Year Flood Hazard Area Structures that Would Impede or Redirect Flood Flows	LOS before Mitigation	NI	NI	NI	NI	NI	NI
	Mitigation Measure	None required.	No mitigation needed; thus, none proposed.				
	LOS after Mitigation	NI	NI	NI	NI	NI	NI
Impact H&H-4: Change in Water Levels in the Old River near Tracy Road Bridge	LOS before Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required	No mitigation needed; thus, none proposed.				
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
Impact H&H-5: Change in Water Levels in the Grant Line Canal near the Grant Line Canal Barrier	LOS before Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required	No mitigation needed; thus, none proposed.				
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
Impact H&H-6: Change in Water Levels in the Middle River near the Howard Road Bridge	LOS before Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required	No mitigation needed; thus, none proposed.				
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
Impact H&H-7: Change in X2 Position	LOS before Mitigation	NI	NI	LTS	LTS	NI	LTS
	Mitigation Measure	None required	No mitigation needed; thus, none proposed.				
	LOS after Mitigation	NI	NI	LTS	LTS	NI	LTS

Table 6-64. Summary of Mitigation Measures for Hydrology, Hydraulics, and Water Management (contd.)

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/CP4A	CP5
Impact H&H-8: Change in Recurrence of Delta Excess Conditions	LOS before Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	No mitigation needed; thus, none proposed.				
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
Impact H&H-9: Change in Deliveries to North-of-Delta CVP Water Service Contractors and Refuges	LOS before Mitigation	PS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	No mitigation needed; thus, none proposed.				
	LOS after Mitigation	PS	LTS	LTS	LTS	LTS	LTS
Impact H&H-10: Change in Deliveries to South-of-Delta CVP Water Service Contractors and Refuges	LOS before Mitigation	PS	B	LTS	B	B	B
	Mitigation Measure	None required.	No mitigation needed; thus, none proposed.				
	LOS after Mitigation	PS	B	LTS	B	B	B
Impact H&H-11: Change in Deliveries to SWP Table A, Contractors	LOS before Mitigation	B	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	No mitigation needed; thus, none proposed.				
	LOS after Mitigation	B	LTS	LTS	LTS	LTS	LTS
Impact H&H-12: Change in Groundwater	LOS before Mitigation	LTS	B	B	B	B	B
	Mitigation Measure	None required.	No mitigation needed; thus, none proposed.				
	LOS after Mitigation	LTS	B	B	B	B	B
Impact H&H-13: Change in Groundwater Quality	LOS before Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	No mitigation needed; thus, none proposed.				
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS

Key:
B = beneficial
CP = Comprehensive Plan
CVP = Central Valley Project
LOS = level of significance
LTS = less than significant
NI = no impact
PS = potentially significant

6.3.5 Cumulative Effects

Chapter 3, "Considerations for Describing the Affected Environment and Environmental Consequences," discusses overall cumulative impacts methodology related to the action alternatives, including the relationship to the CALFED Bay-Delta Program Programmatic EIS/EIR cumulative impacts analysis, qualitative and quantitative assessment, past and future actions in the study area, and significance criteria. Table 3-1, "Present and Reasonably Foreseeable Future Actions Included in the Analysis of Cumulative Impacts, by Resource Area" lists the present and reasonably foreseeable future projects considered quantitatively and qualitatively within the cumulative impacts analysis. This cumulative impacts analysis accounts for potential project impacts combined with the impacts of existing facilities, conditions, land uses, and reasonably foreseeable actions expected to occur in the study area on a qualitative and quantitative level. Past impacts to these resources include dam construction and altered flow regimes, water diversions, flood control facilities, and land use changes.

Actions which are included quantitatively in this cumulative effects analysis are those that are reasonably foreseeable, including actions with current authorization, secured funding for design and construction, and environmental permitting and compliance activities that are substantially complete. As described in Chapter 2, "Alternatives," Section 2.2, "No-Action Alternative," the NEPA No-Action alternative includes all reasonably foreseeable actions included quantitatively in the cumulative effects analysis, but excludes effects for project actions. The future with-project conditions combine project actions with the actions included in the No-Action Alternative (2030 baseline). Therefore, quantitative impact assessments for the future with-project conditions presented in this chapter in Section 6.3.3, "Direct and Indirect Effects," also serve as the quantitative impacts assessments for the cumulative effects analysis. A list of projects included in the Final EIS No-Action Alternative and future with-project impact analyses is located in the Modeling Appendix, Chapter 2, Table 2-1.

Projects which do not meet the parameters of reasonably foreseeable for inclusion in this quantitative cumulative effects analysis but which may have past, present, or reasonably foreseeable cumulative impacts in combination with the proposed project may be included in the cumulative impacts analysis qualitatively. Projects and actions considered include, but are not limited to, North of Delta Offstream Storage Investigation, Bay-Delta Conservation Plan, SJRRP, Davis Woodland Water Supply Project and Central Valley Flood Protection Plan. This section provides an analysis of overall cumulative impacts of the project alternatives with other past, present, and reasonably foreseeable future projects producing related impacts.

The effects of climate change on operations at Shasta Lake could result in changes to H&H. As described in the Climate Change Modeling Appendix, climate change could result in higher reservoir releases in the winter and early spring because of an increase in runoff during these times. The change in winter and early spring releases could necessitate managing flood events resulting from potentially larger storms. Similarly, climate change could result in lower reservoir inflows and Sacramento tributary flows during the late spring and summer because of a decreased snow pack. This reduction in inflow and tributary flow could result in Shasta Lake storage being reduced because of both a reduced ability to capture flows and an increased need to make releases to meet downstream requirements.

CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

As described in Section 6.3.3, no potentially significant impacts would occur under CP1.

When combined with other past, present, and reasonably foreseeable future projects, a change in the Sacramento River flows would be likely. Because Shasta Reservoir is operated to meet flow and water quality requirements in the Sacramento River and the Delta, a new project or program along the Sacramento River and in the Delta could affect H&H resources under CP1. With the implementation of the other past, present, and reasonably foreseeable future projects, it is reasonable to assume that there would not be a reduction in flow requirements or a reduction in the level of protection from current water quality requirements. Therefore, during periods when the CVP and SWP are operated to meet regulatory constraints, the effects of the implementation of the projects described above would be limited.

Water levels in the south Delta could be affected by changes in Delta inflow and export pumping. Although regulatory requirements restrict export pumping when water levels in the south Delta reach certain levels, CP1 combined with other projects could result in changes to water levels during the irrigation season, at a magnitude and frequency that would affect south Delta water users. Accordingly, CP1 combined with a number of other projects and on-going actions could result in potentially significant and unavoidable impacts to south Delta water levels.

Both the X2 position and the Delta outflow are primarily products of Delta inflow and export pumping. As previously mentioned, CP1 combined with other projects could result in changes to Delta inflow and export pumping. Although CP1 would result in rare changes to either the X2 position or the Delta outflow of a magnitude affecting CCWD’s ability to fill Los Vaqueros Reservoir, and would result in a less-than-significant impact on the X2 position, CP1 combined with other projects could result in potentially significant and unavoidable impacts.

As previously described, CP1 would have a beneficial impact on groundwater resources in the CVP/SWP service areas. Similarly, it is unlikely that CP1, when combined with other projects, would result in a decrease in surface water deliveries and an increased reliance on groundwater pumping relative to existing conditions or the No-Action Alternative. Accordingly, no impact on groundwater levels or groundwater quality would occur. Therefore, CP1, combined with other projects, would be likely to have a beneficial effect.

None of the other past, present, and reasonably foreseeable future projects would negatively affect downstream flood management. Consequently, when combined with CP1, either no cumulative impact or a beneficial impact on flood management would occur from past, present or reasonably foreseeable future projects.

As stated previously, effects of climate change on operations of Shasta Lake could include increased inflows and releases at certain times of the year, and decreased inflows at other times. The additional storage associated with CP1 potentially would diminish these effects and allow Shasta Lake to capture some of the increased runoff in the winter and early spring for release in late spring and summer. Under climate change, additional impacts from CP1 on flood management, water supply, south Delta water levels, and groundwater management would be less adverse (or beneficial) than without climate change, and would be less than significant. Therefore, under the anticipated effects of climate change, CP1 would not have a significant cumulative effect, and could be beneficial.

CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

As described in Section 6.3.3, no potentially significant impacts would occur under CP2.

When combined with the other past, present, and reasonably foreseeable future projects, a change in the Sacramento River flows would be likely. Because Shasta Reservoir is operated to meet flow and water quality requirements in the Sacramento River and the Delta, a new project or program along the Sacramento River and in the Delta could affect the H&H resources under CP2. With the implementation of the other past, present, and reasonably foreseeable future projects, it is reasonable to assume that there would not be a reduction in flow requirements or a reduction in the level of protection from current water quality requirements. Therefore, during periods when the CVP and SWP are operated to meet regulatory constraints, the effects of the implementation of the projects described above would be limited.

Water levels in the south Delta could be affected by changes in Delta inflow and export pumping. Although regulatory requirements restrict export pumping when water levels in the south Delta reach certain levels, CP2 combined with other projects could result in changes to water levels during the irrigation season, at a magnitude and frequency that would affect south Delta water users. Accordingly, CP2 combined with other projects could result in potentially significant and unavoidable impacts to south Delta water levels.

Both the X2 position and the Delta outflow are primarily products of Delta inflow and export pumping. As previously mentioned, CP2 combined with other projects could result in changes to Delta inflow and export pumping. Although CP2 would result in rare changes to either the X2 position or the Delta outflow of a magnitude affecting CCWD's ability to fill Los Vaqueros Reservoir, and would result in a less-than-significant impact on the X2 position, CP2 combined with other projects possibly could result in potentially significant and unavoidable impacts.

As previously described, CP2 would have a beneficial impact on groundwater resources in the CVP/SWP service areas. Similarly, it is unlikely that CP2, when combined with other projects, would result in a decrease in surface water deliveries and an increased reliance on groundwater pumping relative to existing conditions or the No-Action Alternative. Accordingly, no impact on groundwater levels or groundwater quality would occur. Therefore, CP2, combined with other projects, would be likely to have a beneficial effect.

None of the other past, present, and reasonably foreseeable future projects would negatively affect downstream flood management. Consequently, when combined with CP2, either no cumulative impact or a beneficial impact on flood management would occur from past, present or reasonably foreseeable future projects.

As stated previously, effects of climate change on operations of Shasta Lake could include increased inflows and releases at certain times of the year, and decreased inflows at other times. The additional storage associated with CP2 potentially would diminish these effects and allow Shasta Lake to capture some of the increased runoff in the winter and early spring for release in late spring and summer. Under climate change, additional impacts from CP2 on flood management, water supply, south Delta water levels, and groundwater management would be less adverse (or beneficial) than without climate change, and would be less than significant. Therefore, even under the anticipated effects of climate change, CP2 would not have a significant cumulative effect, and could be beneficial.

CP3 – 18.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply

As described in Section 6.3.3, no potentially significant impacts would occur under CP3.

When combined with the other past, present, and reasonably foreseeable future projects, a change in the Sacramento River flows would be likely. Because Shasta Reservoir is operated to meet flow and water quality requirements in the Sacramento River and the Delta, a new project or program along the Sacramento River and in the Delta could affect the H&H resources under CP3. With the implementation of the other past, present, and reasonably foreseeable future projects, it is reasonable to assume that there would not be a reduction in flow requirements or a reduction in the level of protection from current water quality requirements. Therefore, during periods when the CVP and SWP are operated to meet regulatory constraints, the effects of the implementation of the projects described above would be limited.

Water levels in the south Delta could be affected by changes in Delta inflow and export pumping. Although regulatory requirements restrict export pumping when water levels in the south Delta reach certain levels, CP3 combined with other projects could result in changes to water levels during the irrigation season, at a magnitude and frequency that would affect south Delta water users. Accordingly, CP3 combined with other projects could result in potentially significant and unavoidable impacts to south Delta water levels.

Both the X2 position and the Delta outflow are primarily products of Delta inflow and export pumping. As previously mentioned, CP3 combined with other projects could result in changes to Delta inflow and export pumping. Although CP3 would result in rare changes to either the X2 position or the Delta outflow of a magnitude affecting CCWD's ability to fill Los Vaqueros Reservoir, and would result in a less-than-significant impact on the X2 position, CP3 combined with other projects possibly could result in potentially significant and unavoidable impacts.

As previously described, CP3 would have a beneficial impact on groundwater resources in the CVP/SWP service areas. Similarly, it is unlikely that CP3, when combined with a number of other projects, would result in a decrease in surface water deliveries and an increased reliance on groundwater pumping relative to existing conditions or the No-Action Alternative. Accordingly, no impact on groundwater levels or groundwater quality would occur. Therefore, CP3, combined with a number of other projects, would be likely to have a beneficial effect.

None of the other past, present, and reasonably foreseeable future projects would negatively affect downstream flood management. Consequently, when combined with CP3, either no cumulative impact or a beneficial impact on flood management would occur from past, present or reasonably foreseeable future projects.

As stated previously, effects of climate change on operations of Shasta Lake could include increased inflows and releases at certain times of the year, and decreased inflows at other times. The additional storage associated with CP3 potentially would diminish these effects and allow Shasta Lake to capture some of the increased runoff in the winter and early spring for release in late spring and summer. Under climate change, additional impacts from CP3 on flood management, water supply, south Delta Water levels, and groundwater management would be less adverse (or beneficial) than without climate change, and would be less than significant. Therefore, under the anticipated effects of climate change, CP3 would not have a significant cumulative effect, and could be beneficial.

CP4 and CP4A – 18.5-Foot Dam Raise, Anadromous Fish Focus With Water Supply Reliability

As described in Section 6.3.3, no potentially significant impacts would occur under CP4 or CP4A.

When combined with the other past, present, and reasonably foreseeable future projects, a change in the Sacramento River flows would be likely. Because Shasta Reservoir is operated to meet flow and water quality requirements in the Sacramento River and the Delta, a new project or program along the Sacramento River and in the Delta could affect the H&H resources under CP4 or CP4A. With the implementation of the other past, present, and reasonably foreseeable future projects, it is reasonable to assume that there would not be a reduction in flow requirements or a reduction in the level of protection from current water quality requirements. Therefore, during periods when the CVP and SWP are operated to meet regulatory constraints, the effects of the implementation of the projects described above would be limited.

Water levels in the south Delta could be affected by changes in Delta inflow and export pumping. Although regulatory requirements restrict export pumping when water levels in the south Delta reach certain levels, CP4 or CP4A combined with other projects could result in changes to water levels during the irrigation season, at a magnitude and frequency that would affect south Delta water users. Accordingly, CP4 or CP4A combined with other projects could result in potentially significant and unavoidable impacts to south Delta water levels.

Both the X2 position and the Delta outflow are primarily products of Delta inflow and export pumping. As previously mentioned, CP4 or CP4A combined with other projects could result in changes to Delta inflow and export pumping. Although CP4 or CP4A would result in rare changes to either the X2 position or the Delta outflow of a magnitude affecting CCWD’s ability to fill Los Vaqueros Reservoir, and would result in a less-than-significant impact on the X2 position, CP4 or CP4A combined with other projects possibly could result in potentially significant and unavoidable impacts.

As previously described, CP4 or CP4A would have a beneficial impact on groundwater resources in the CVP/SWP service areas. Similarly, it is unlikely that CP4 or CP4A, when combined with other projects, would result in a decrease in surface water deliveries and an increased reliance on groundwater pumping relative existing conditions or the No-Action Alternative. Accordingly, no impact on groundwater levels or groundwater quality would occur. Therefore, CP4 or CP4A, combined with other projects, would be likely to have a beneficial effect.

None of the other past, present, and reasonably foreseeable future projects would negatively affect downstream flood management. Consequently, when combined with CP4 or CP4A, either no cumulative impact or a beneficial impact on flood management would occur from past, present and reasonably foreseeable future projects.

As stated previously, effects of climate change on operations of Shasta Lake could include increased inflows and releases at certain times of the year, and decreased inflows at other times. The additional storage associated with CP4 or CP4A could potentially would diminish these effects and allow Shasta Lake to capture some of the increased runoff in the winter and early spring for release in late spring and summer. Under climate change, additional impacts from CP4 or CP4A on flood management, water supply, south Delta water levels, and groundwater management would be less adverse (or beneficial) than without climate change, and would be less than significant. Therefore, under the anticipated effects of climate change, CP4 or CP4A would not have a significant cumulative effect, and could be beneficial.

CP5 – 18.5-Foot Dam Raise, Combination Plan

As described in Section 6.3.3, no potentially significant impacts would occur under CP5.

When combined with the other past, present, and reasonably foreseeable future projects, a change in the Sacramento River flows would be likely. Because Shasta Reservoir is operated to meet flow and water quality requirements in the Sacramento River and the Delta, a new project or program along the Sacramento River and in the Delta could affect the H&H resources under CP5. With the implementation of the other past, present, and reasonably foreseeable future projects, it is reasonable to assume that there would not be a reduction in flow requirements or a reduction in the level of protection from current water quality requirements. Therefore, during periods when the CVP and SWP are operated to meet regulatory constraints, the effects of the implementation of the projects described above would be limited.

Water levels in the south Delta could be affected by changes in Delta inflow and export pumping. Although regulatory requirements restrict export pumping when water levels in the south Delta reach certain levels, CP5 combined with other projects could result in changes to water levels during the irrigation season, at a magnitude and frequency that would affect south Delta water users. Accordingly, CP5 combined with other projects could result in potentially significant and unavoidable impacts to south Delta water levels.

Both the X2 position and the Delta outflow are primarily products of Delta inflow and export pumping. As previously mentioned, CP5 combined with other projects could result in changes to Delta inflow and export pumping. Although CP5 would result in rare changes to either the X2 position or the Delta outflow of a magnitude affecting CCWD’s ability to fill Los Vaqueros Reservoir, and would result in a less-than-significant impact on the X2 position, CP5 combined with other projects could result in potentially significant and unavoidable impacts.

As previously described, CP5 would have a beneficial impact on groundwater resources in the CVP/SWP service areas. Similarly, it is unlikely that CP5, when combined with other projects, would result in a decrease in surface water deliveries and an increased reliance on groundwater pumping relative to existing conditions or the No-Action Alternative. Accordingly, no impact on groundwater levels or groundwater quality would occur. Therefore, CP5, combined with other projects, would be likely to have a beneficial effect.

None of the other past, present, and reasonably foreseeable future projects would negatively affect downstream flood management. Consequently, when combined with CP5, either no cumulative impact or a beneficial impact on flood management would occur from past, present or reasonably foreseeable future projects.

As stated previously, effects of climate change on operations of Shasta Lake could include increased inflows and releases at certain times of the year, and decreased inflows at other times. The additional storage associated with CP5 potentially would diminish these effects and allow Shasta Lake to capture some of the increased runoff in the winter and early spring for release in late spring and summer. Under climate change, additional impacts from CP5 on flood management, water supply, south Delta water levels, and groundwater management would be less adverse (or beneficial) than without climate change, and would be less than significant. Therefore, under the anticipated effects of climate change, CP5 would not have a significant cumulative effect, and could be beneficial.

This page left blank intentionally.

Chapter 7
Water Quality

7.1 Affected Environment

This section describes the affected environment related to water quality for the dam and reservoir modifications proposed under SLWRI action alternatives. For more detail, please see the *Water Quality Technical Report*.

7.1.1 Overview of Water Quality Conditions

Surface water quality in the study area is affected by natural runoff, agricultural return flows, abandoned mines, construction, logging, grazing, and operations of flow-regulating facilities, urbanization, and recreation. This section discusses key water quality constituents of concern (i.e., temperature, sediments, and metals), the factors influencing their concentrations, and the regulatory objectives associated with maintaining beneficial uses.

The following discussion provides an overview of water quality and its relationship to beneficial uses throughout the primary and extended study areas. This section is followed by discussions of key water quality parameters that influence beneficial uses to varying degrees within the study areas: temperature, sediment, and metals.

Shasta Lake and Vicinity

This section addresses water quality in the Shasta Lake and vicinity portion of the primary study area (see Figure 7-1). It focuses on the six arms of Shasta Lake and tributaries that enter into Shasta Lake from the surrounding watersheds.

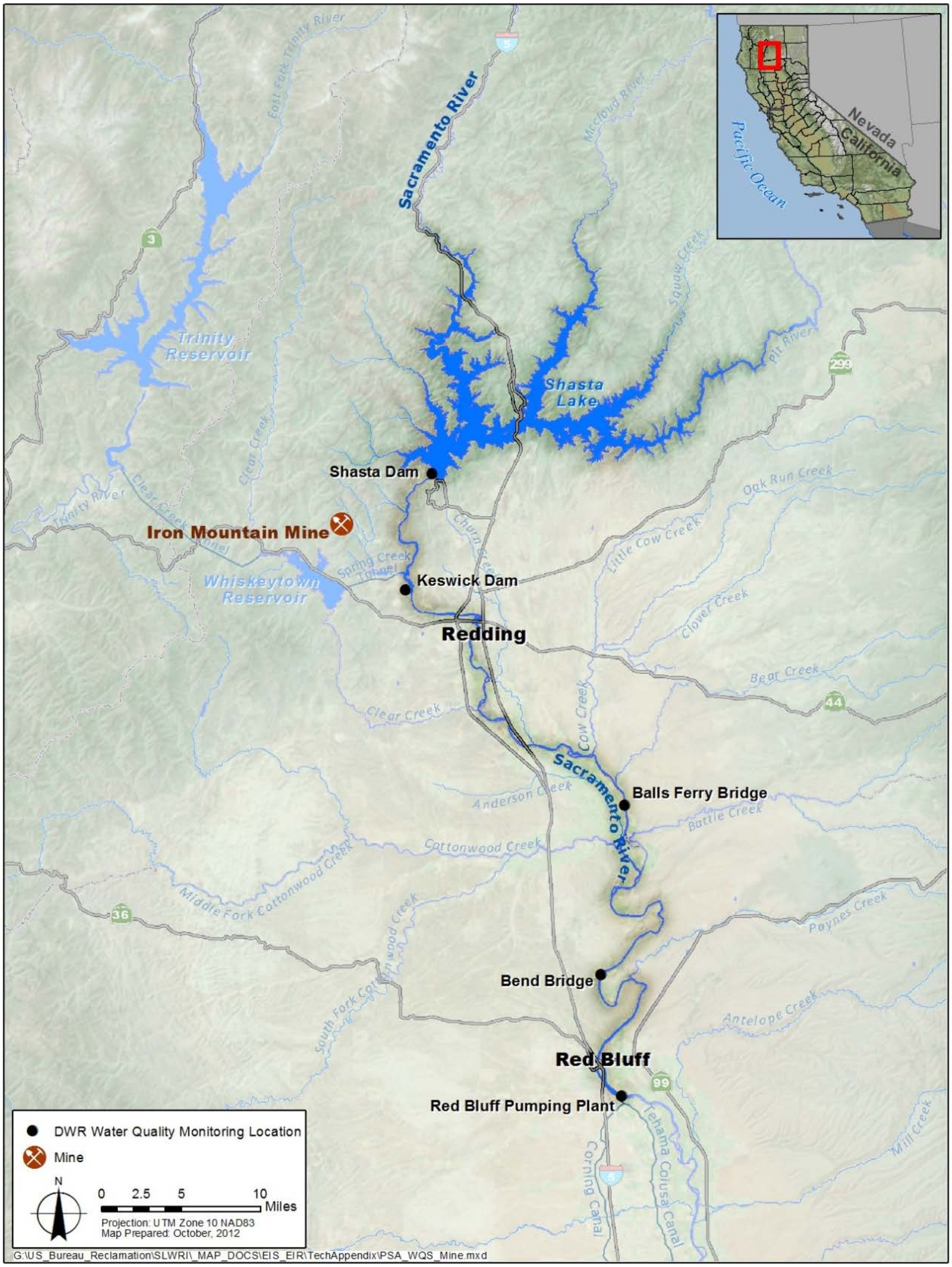


Figure 7-1. Upper Sacramento River Primary Study Area

Water quality in this portion of the primary study area generally meets the standards for beneficial uses identified in the Basin Plan (CVRWQCB 2011). However, some areas exist where the water quality does not meet the standards during periods of storm runoff because of past management activities, large wildfires, or drainage from historic mining and processing operations. All of Shasta Lake is listed by the EPA as impaired by mercury on the Federal Clean Water Act (CWA) 2008–2010 Section 303(d) list. A two-year study conducted by the State Water Resources Control Board (State Water Board) sampled mercury accumulations in fish at a number of locations throughout Shasta Lake. This study documented elevated levels of mercury in some specimens (Davis et al. 2010). In addition, West Squaw Creek below the Balakala Mine, lower Little Backbone Creek, lower Horse Creek, and Town Creek are impaired water bodies under Section 303(d) of the CWA. All of these water bodies drain into the southwestern-most edge of Shasta Lake. Within Little Backbone Creek and West Squaw Creek, the waters are locally limited by low pH and elevated concentrations of heavy metals caused by drainage from abandoned mines and are listed as impaired on the Section 303(d) list (CVRWQCB 2003a).

Nutrient inputs and bacteria are not of concern in the Sacramento and McCloud arms (USFS 1998); however, they may be an issue in the Pit Arm as a result of runoff from agricultural and range lands in the upper Pit River watershed. In addition, data suggest that sediment and turbidity locally affect beneficial uses, mainly contact recreation.

The quality of surface waters in Shasta County is generally considered good, although some water bodies are affected by nonpoint pollution sources that influence surface water quality, including high turbidity from controllable sediment discharge sources (e.g., land development and roads); high concentrations of nitrates and dissolved solids from range and agricultural runoff or septic tank failures; contaminated street and lawn runoff from urban areas, roads, and railroads; acid mine drainage and heavy metal discharges from historic mining and processing operations; and warm-water discharges into cold-water streams.

The quality of water in underground basins and water-bearing soils is also considered generally good throughout most of Shasta County and is discussed in more detail in Chapter 6, “Hydrology, Hydraulics, and Water Management.” Potential hazards to groundwater quality involve nitrates and dissolved solids from agricultural and range practices and septic tank failures. The ability of soils in Shasta County to support septic tanks and on-site wastewater treatment systems is generally severely limited, particularly on older valley terrace soils and certain loosely confined volcanic soils in the eastern portions of the county (CVRWQCB 2011).

The surface water quality of streams and lakes draining Shasta-Trinity National Forest (STNF) and adjacent private lands generally meets standards for beneficial uses defined by the Basin Plan (CVRWQCB 2011). However, some areas exist where the water quality does not meet the standards during periods of storm runoff because of past management activities, large wildfires, or as a result of drainage from historic mining and processing operations. The U.S. Environmental Protection Agency (EPA) has listed the West Squaw Creek below the Balakala Mine, the lower Little Backbone Creek, the lower Horse Creek, and the Town Creek as impaired water bodies under Section 303(d) of the Federal Clean Water Act (CWA). All of these water bodies drain into the Main Arm of Shasta Lake. In the 1995 Land and Resource Management Plan (LRMP), the STNF acknowledged the drainages that are all listed by the cumulative impacts of successive activities, such as road construction and timber harvesting on private and National Forest System (NFS) lands contribute to the degradation of water quality on NFS lands (USFS 1995). In addition to NFS and U.S. Department of the Interior, Bureau of Land Management (BLM) lands in the watersheds tributary to Shasta Lake, there have been similar types of activities on private lands. Watershed assessments and analysis conducted by the STNF, BLM, and the Sacramento River Exchange for most of the watersheds tributary to Shasta Lake acknowledge that roads and wildfires continue to have impacts to water quality in various portions of these watersheds (The River Exchange 2010).

In 2012, the Bagley fire burned large portions of the McCloud River and Squaw Creek watersheds with varying levels of intensity. High-intensity rainfall events in November and December 2012 resulted in extensive erosion throughout the fire area, including roads, upland areas, and riparian areas. Recent studies conducted by STNF staff (STNF 2014) document road-related sedimentation effects from this fire, providing a good example of the interrelationship between fire and erosional processes. Preliminary USFS results indicate that 2,200,000 tons of sediment has been eroded from upland areas in the Squaw Creek watershed. Approximately 452,000 tons are stored in channel networks, and more than 1,700,000 tons of sediment has been delivered to Shasta Lake. Putting this in perspective, volume estimates for shoreline erosion (see Chapter 4, “Geology, Geomorphology, Minerals, and Soils”) range between 187,110 and 289,170 tons[1] per year. These values are about 10 percent of the erosion associated with the Bagley fire.

Upper Sacramento River (Shasta Dam to Red Bluff)

Tributaries to the Upper Sacramento River, and place names referred to in the text are shown in Figure 7-1. The main sources of water in the Sacramento River below Keswick Dam are rain and snowmelt that collect in upstream reservoirs and are released in response to water needs or flood control. The quality of surface water downstream from Keswick Dam is also influenced by other human activities along the Sacramento River downstream from the dam, including agricultural, historical mining, and municipal and industrial (M&I) inputs.

[1] Conversion factor of 1.215 from cubic yards to tons.

The quality of water in the Sacramento River is relatively good. Only during conditions of stormwater-driven runoff are water quality objectives typically not met (Domagalski et al. 2000). Water quality issues within the primary study area of the Sacramento River include the presence of mercury, pesticides such as organochlorine pesticides, trace metals, turbidity, and toxicity from unknown origin (CALFED 2000a).

Water quality in the Sacramento River and its major tributaries above Red Bluff Pumping Plant (RBPP) is generally good (Table 7-1). Nutrients such as nitrate were found to be low throughout the Sacramento River basin (Domagalski and Dileanis 2000, as cited in Domagalski et al. 2000). Water temperature is a principal water quality issue in the upper Sacramento River between Keswick Dam and RBPP.

Table 7-1. Summary of Conventional Water Quality Constituents Collected in the Sacramento River at Red Bluff from 1996 to 1998

Constituent (unit)	Water Quality Objective	Average Measurement
Conventional Physical and Chemical Constituents		
Temperature	< 2.5ºF [1]	52.7ºF
Conductivity (µS/cm)	–	116
Dissolved Oxygen (mg/L)	7.0 [2]	10.7
Dissolved Oxygen Saturation (%)	85 [2]	99
pH (standard unit)	6.5 to 8.5 [3]	7.8
Alkalinity (mg/L $CaCO_3$)	–	48.3
Total Hardness (mg/L $CaCO_3$)	–	46.6
Suspended Sediment (mg/L)	–	38.8
Calcium (mg/L)	narrative [4]	10.3
Magnesium (mg/L)	–	5.0
Sodium (mg/L)	–	5.8
Potassium (mg/L)	–	1.1
Chloride (mg/L)	500 [5]	2.4
Conventional Physical and Chemical Constituents		
Sulfate (mg/L)	500 [5]	4.5
Silica (mg/L)	–	20.5
NO2 + NO3 (mg/L N)	NO3 < 10 [6]	0.12
Total Phosphorus (mg/L P)	–	0.0477

Table 7-1. Summary of Conventional Water Quality Constituents Collected in the Sacramento River at Red Bluff from 1996 to 1998 (contd.)

Constituent (unit)	Water Quality Objective	Average Measurement
Trace Metals		
Arsenic (µg/L)	50 [7]	1.0
Chromium (µg/L)	180 [7]	1.0
Copper (µg/L)	5.1 [7]	1.6
Mercury (µg/L)	0.050 [7]	0.0045
Nickel (µg/L)	52 [7]	1.2
Zinc (µg/L)	120 [7]	2.3
Organic Pesticides		
Molinate (ng/L)	13,000 [8]	< 60
Simazine (ng/L)	3,400 [9]	< 22
Carbofuran (mg/L)	40,000 [5], 500 [9]	< 31
Diazinon (mg/L)	51 [10]	< 28
Carbaryl (ng/L)	700 [11]	< 41
Thiobencarb (ng/L)	1,000 [1]	< 38
Chlorpyrifos (ng/L)	14 [10]	< 25
Methidathion (ng/L)	–	< 38

Source: CBDA 2005

Notes:
[1] The Water Quality Control Plan for the Sacramento River and San Joaquin River Basins (Basin Plan) water quality objective for allowable change from controllable factors.
[2] Basin Plan water quality objective.
[3] Basin Plan water quality objective; < 0.5 allowable change from controllable factors.
[4] Basin Plan narrative objective: Water will not contain constituent in concentrations that would cause nuisance or adversely affect beneficial uses.
[5] Secondary drinking water maximum contaminant level (MCL).
[6] Primary drinking water MCL.
[7] California Toxics Rule (CTR) aquatic life criteria for 4-day average dissolved concentration.
[8] CTR human health maximum criteria total recoverable concentration.
[9] California Department of Fish and Game hazard assessment value.
[10] California Department of Fish and Game aquatic life guidance value for 4-day average concentration.
[11] U.S. Environmental Protection Agency Integrated Risk Information System reference dose for drinking water quality.

Key:
– = not applicable
°F = degrees Fahrenheit
% = percent
µg/L = micrograms per liter
µS/cm = microSiemens per centimeter
$CaCO_3$ = calcium carbonate
mg/L = milligrams per liter
N = nitrogen
ng/L = nanograms per liter
NO_2 = nitrate
NO_3 = nitrite
P = phosphorus

Although all trace metals shown in Table 7-1 were well below their established water quality objectives, one of the principal water quality issues in the upper Sacramento River portion of the primary study area is acid mine drainage and associated heavy-metal contamination from the Spring Creek drainage and other abandoned mining sites. It should be noted that the U.S. Geological Survey

(USGS) study detected mercury, but it did not exceed the criterion of ambient level specified in the California Toxics Rule; however, California Toxics Rule levels for mercury are not protective to prevent the high concentration of mercury found in fish tissue. In addition to heavy metal contamination, the Central Valley Regional Water Quality Control Board (CVRWQCB) determined that the 25-mile reach of the Sacramento River from Keswick Dam downstream to Cottonwood Creek is impaired because the water periodically contains levels of dissolved cadmium, copper, and zinc that exceed levels identified to protect aquatic organisms. The 26-mile reach from Keswick Dam to Red Bluff is listed for unknown sources of toxicity (CVRWQCB 2007a).

Lower Sacramento River and Delta

Water quality in the lower Sacramento River is affected by agricultural runoff, acid mine drainage, stormwater discharges, water releases from dams, diversions, and urban runoff. However, the flow volumes generally provide sufficient dilution to prevent excessive concentrations of contaminants in the river.

Several total maximum daily loads (TMDL) are currently proposed for the lower Sacramento River. In addition, the Sacramento River downstream from Red Bluff to Knights Landing is listed as an impaired water body under the EPA's Section 303(d) list for mercury and unknown toxicity. Elevated metals and pesticide levels have been found at some sites in the Sacramento River Valley downstream from Knights Landing. The parameters of concern in the Sacramento River from Knights Landing to the Sacramento-San Joaquin Delta (Delta) include diazinon, mercury, and unknown sources of toxicity (CVRWQCB 2007a, 2007b).

Water quality in the Delta is highly variable temporally and spatially. It is a function of complex circulation patterns that are affected by inflows, pumping for Delta agricultural operations and exports, operation of flow control structures, and tidal action. The existing water quality problems of the Delta system may be categorized as presence of toxic materials, eutrophication and associated fluctuations in dissolved oxygen, presence of suspended sediments and turbidity, salinity, and presence of bacteria (State Water Board 1999).

The Delta waterways within the area under the CVRWQCB's jurisdiction are listed as impaired on the EPA's 303(d) list for dissolved oxygen, electrical conductivity (EC), dichlorodiphenyl-trichloroethane, mercury, Group A pesticides, diazinon and chlorpyrifos, and unknown toxicity (CVRWQCB 2003b). The area of the Delta that is under the jurisdiction of the San Francisco Bay Regional Water Quality Control Board (RWQCB) is listed as impaired for mercury, chlordane, selenium, dichlorodiphenyl-trichloroethane, dioxin compounds, polychlorinated biphenyl compounds, dieldrin, nickel, exotic species, and furan compounds (SFBRWQCB 2007).

Organic carbon in the Delta originates from runoff from agricultural and urban land, drainage water pumped from Delta islands that have soils with high organic matter, runoff and drainage from wetlands, wastewater discharges, and primary production in Delta waters. Delta agricultural drainage can also contain high levels of nutrients, suspended solids, organic carbon, minerals (salinity), and trace chemicals such as organophosphate, carbamate, and organochlorine pesticides.

Salinity is also an important water quality constituent in the Delta. Salinity in the Delta is the result of tidal exchange with San Francisco Bay, variations in freshwater inflow from the San Joaquin and Sacramento rivers, agricultural and urban exports/diversions, and agricultural return flows. During dry conditions, seawater intrusion is the primary factor influencing Delta salinity and can adversely affect agricultural and municipal uses. The highest concentrations typically occur in late summer or early fall.

CVP/SWP Service Areas

The CVP and SWP service areas are affected by water quality from the Delta. Particular water quality concerns are those related to salinity and drinking-water quality. Salinity is an issue because excessive salinity may adversely affect crop yields and require more water for salt leaching, may require additional M&I treatment, may increase salinity levels in agricultural soils and groundwater, and is the primary water quality constraint to recycling wastewater (CALFED 2000b).

Constituents that affect drinking-water quality include bromide, natural organic matter, microbial pathogens, nutrients, total dissolved solids (TDS), hardness, alkalinity, pH, organic carbon, disinfection byproducts, and turbidity.

7.1.2 Sediment

Shasta Lake and Vicinity

Sediment-caused turbidity is one of the limiting water quality issues for Shasta Lake and its tributaries. It is a noticeable recurring water quality problem that affects beneficial uses, including recreation and fisheries. Within the reservoir, turbid water results from clay- and silt-sized soil particles suspended in the water column. Under certain conditions, inflow to the Pit Arm appears to be influenced by water quality conditions upstream from Shasta Lake, but monitoring data are not available to adequately document this phenomenon.

Before the construction of Shasta Dam, the widespread loss of vegetation caused by historic copper mining and smelting operations resulted in large-scale erosion, particularly in the watersheds that are tributary to the Main Body of Shasta Lake and the Squaw Creek Arm. In addition to sediment sources from upland areas, including roads and historic mining features, the construction and operation of Shasta Dam continue to influence erosional processes that introduce sediment into Shasta Lake, causing turbid conditions that are visible to the casual observer.

Nonpoint sources of fine sediment that increase turbidity in Shasta Lake include sediment discharge from tributaries, wave-related erosion below and adjacent to the fluctuating water surface, and surficial erosion of exposed surfaces as the lake levels fluctuate (USFS 2014). Erosion of the fine-textured soil and rock types that constitute much of the shoreline is a predominant factor in causing turbidity. The turbid water is noticeable along the shoreline throughout the year, but typically increases during wind and runoff events. Plumes of turbid water entering from tributaries are also visible periodically throughout the year. The fluctuation of lake levels, combined with various wave-generating processes, also influences the degree and location of erosion-related turbidity. Turbidity and, to a lesser degree, sediment suspended in the water column influence recreational uses of the lake, including fishing, swimming, and boating, by decreasing the clarity of the water along the shoreline.

Sediment discharge from tributaries to Shasta Lake (perennial and intermittent channels) is episodic in terms of magnitude and frequency. Initially, sediment discharged into Shasta Lake is stored in deltaic deposits. Subsequently, some portion of this sediment load is remobilized, dependent on site-specific conditions such as channel gradient and particle size. Over time, sediment stored in these channels and associated deltas may be transported through channels within the drawdown zone to locations deeper in the reservoir. Depending on reservoir fluctuations, these sediment deposits may remain in place for some period of time before being subjected to erosional processes, typically associated with wave erosion and streambank erosion. These erosional processes are more pronounced during periods of reservoir drawdown.

Although some amount of fine sediment is transported downstream from Shasta Dam, the size and location of the reservoir provide an efficient sediment trap for material typically mobilized as bedload. A 2011 report that summarizes 2005 USGS turbidity records indicates that some turbidity records for the Sacramento River upstream from Shasta Lake exceeded the apparent measuring capability of 1,000 nephelometric turbidity units (ntu). Turbidity readings at Shasta Dam for the same time period were much lower (Pace Engineers 2011). This report reinforces the premise that location of the discharge from Shasta Dam (at-depth) acts to buffer discharge of turbid water most of the time. Additional discussion of erosional processes is provided in Chapter 4, “Geology, Geomorphology, Minerals, and Soils.”

Upper Sacramento River (Shasta Dam to Red Bluff)

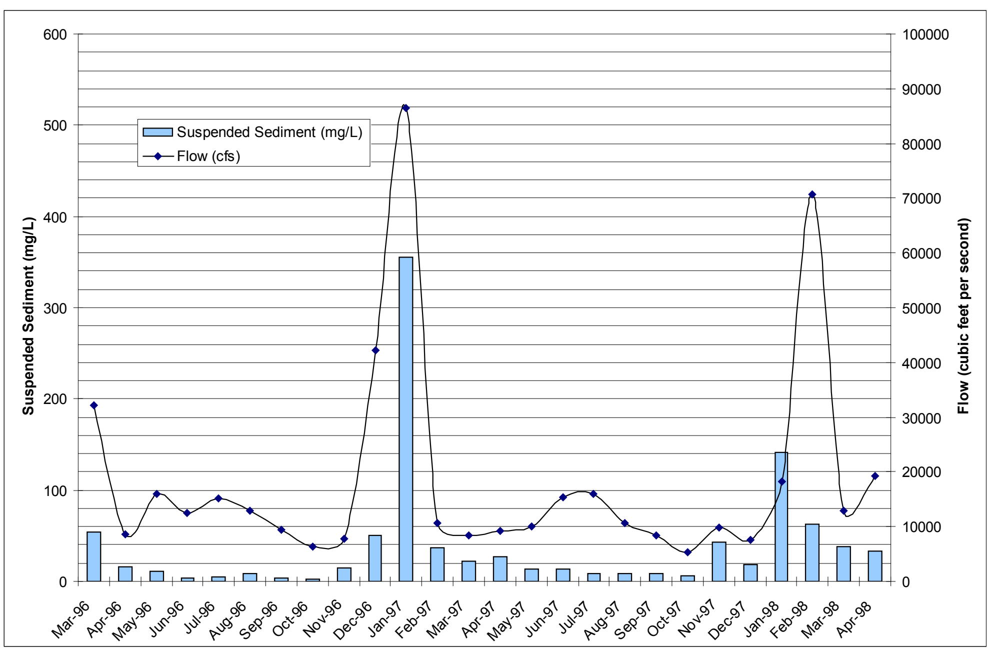
Rates of loading and discharge of suspended sediment within the upper Sacramento River watershed have been altered by activities such as mining, smelting, agriculture, urbanization, and dam construction. The storage and diversion of water within reservoirs for hydroelectric or other purposes can affect sediment yield, downstream sediment levels, and transport characteristics.

In particular, dams such as Shasta can trap sediment and result in the depletion of coarse sediments needed by fisheries. This has resulted in the creation of gravel replenishment programs on the upper Sacramento River as part of the Central Valley Project Improvement Act restoration program.

Historic hydraulic gold mining has probably had the greatest effect on sediment yield in the Sacramento River watershed (Wright and Schoellhamer 2004). During the late 1800s, such mining introduced mass quantities of silt, sand, and gravel into the Sacramento River system. Suspended sediment was washed downstream into the Delta. Current sediment transport patterns in the Sacramento River watershed are greatly affected by the trapping of sediment in reservoirs such as Shasta Lake (Wright and Schoellhamer 2004).

Characteristics of peak-flow events are fundamental regulators of sediment mobilization, bed scour, riparian recruitment, and bank erosion. However, upstream sediment supply rates and sediment load distribution also affect suspended sediment loading (CALFED 2003). The upper Sacramento River contributes little coarse sediment from erosion because it is bounded by erosion-resistant bedrock and terrace deposits (Stillwater Sciences 2006). Therefore, today a decreasing trend in suspended sediment exists in the Sacramento River (Wright and Schoellhamer 2004).

USGS assessed concentrations of suspended sediment in the Sacramento River at Big Bend above Red Bluff from February 1996 to April 1998 (USGS 2000a). Concentrations of suspended sediment ranged from 3 milligrams per liter (mg/L) to 355 mg/L, with an average of 38.8 mg/L (see Figure 7-2).



Source: USGS 2000a

Figure 7-2. Concentrations of Suspended Sediment and Associated Flows in the Sacramento River Above Big Bend near Red Bluff

Lower Sacramento River and Delta

Delivery of suspended sediment from the Sacramento River to the Delta and finally to San Francisco Bay decreased by about one-half during the period 1957 to 2001 (Wright and Schoellhamer 2004). Factors contributing to this trend in sediment yield included the depletion of erodible sediment from hydraulic mining in the late 1800s, trapping of sediment in reservoirs, riverbank protection, altered land uses, and levee construction.

Sediment supply to the Sacramento and San Joaquin river watersheds has declined over the last few decades because dams on rivers and other water management actions have resulted in less sediment transport (CALFED 2000c), although agricultural drainage in the Delta often contains high levels of suspended sediments (Reclamation and DWR 2005). Sediments that include fine sands, silts, and clays are transported by rivers and the Yolo Bypass into the Delta. Coarser materials are deposited at points higher up in the river basins. Sands typically are transported in the bed load, while clays and silts move in the suspended load. The suspended load is composed of generally finer materials moving downstream in the water column. Sediment loads from the Sacramento River are higher than those from the San Joaquin River (Reclamation and DWR 2005).

Hydraulic gold mining, particularly through the major westerly flowing tributaries such as the American, Feather, Yuba, and Bear rivers, may also affect sediment transport in the extended study area. USGS found that the Sacramento River is the primary supplier of suspended sediment to the Delta.

CVP/SWP Service Areas

Some suspended sediments are transported within the CVP and SWP service areas, but turbidity and sedimentation are not issues within the service areas (CALFED 2000c).

7.1.3 Temperature

Shasta Lake and Vicinity

Water temperature is an important water quality parameter affecting the beneficial uses of Shasta Lake and its tributaries, including contact and noncontact recreation and aquatic organisms. Within the reservoir, water temperature commonly controls the growth of algae and the rate of biochemical processes. Shasta Lake periodically stratifies and a thermocline develops on an annual basis, although turnover is incomplete and the lake has not been known to freeze over (Bartholow et al. 2001). Strong stratification of the reservoir occurs during summer at a depth of 10 to 15 meters. This stratification isolates the epilimnion from nutrients available in the deeper hypolimnion, segregating spring and fall algal blooms when water temperatures might otherwise support algal production in the euphotic zone, the zone close to the surface that provides opportunities for photosynthesis. The period of stratification generally overlaps with the peak recreation season (May to September), when surface water temperatures are comfortable for contact recreation activities. During fall, the stratification dissipates and the surface water temperature is reduced.

Shasta Dam operations greatly influence the annual and seasonal water temperature of the reservoir. The wetness of a given water year or series of years generally controls the mean annual water temperature. The current temperature regime of Shasta Lake is related to CVP operational requirements, including those necessary to optimize the water temperatures in the Sacramento River downstream from Keswick Dam. Overall, the tributaries that enter Shasta Lake meet the Basin Plan water quality objective for temperature.

Upper Sacramento River (Shasta Dam to Red Bluff)

Water temperature in the Sacramento River from Shasta Dam to Keswick Reservoir is determined primarily by the temperature of Shasta Dam release flows. At Keswick Reservoir, Shasta Dam release flows mix with flows from diverted through the Spring Creek Tunnel from Whiskeytown Reservoir, and are released back into the Sacramento River from Keswick Dam.

Water temperature for rivers within the Sacramento River basin is reportedly maintained consistent with regulatory requirements (e.g., NMFS Biological Opinion (BO)) most of the time, but temperature management can be difficult during low-flow periods (USGS 2000a). Historically, low-flow events and a lack of flexibility in dam operations can cause water temperatures to periodically approach critical levels for sustaining juvenile salmon populations. In addition to low flows, high water temperatures released from reservoirs, coupled with natural instream warming, can cause elevated river water temperatures (Vermeyen 1997).

A number of water quality objectives exist for the upper Sacramento River. The Basin Plan specifies that water temperature will not be elevated above 56 degrees Fahrenheit (°F) from Keswick Dam to Hamilton City (+9). In addition, the Basin Plan specifies that at no time or place will the temperature of cold or warm intrastate waters be increased more than 5°F above natural receiving-water temperature (CVRWQCB 2011). Keswick Dam releases are managed to meet temperature control requirements.

On December 15, 2008, USFWS issued the *Formal Endangered Species Act Consultation on the Proposed Coordinated Operations of the CVP and SWP* (2008 USFWS BO) for delta smelt and its critical habitat. On June 4, 2009, NMFS issued the *BO and Conference Opinion on the Long-Term Operations of the CVP and SWP* (2009 NMFS BO) for listed anadromous fishes and marine mammal species and their critical habitats. According to the 2009 NMFS BO, the Sacramento River water temperatures will be below 56°F at compliance locations between Balls Ferry and Bend Bridge from April 15 through September 30 to protect winter-run Chinook salmon, and when possible, not in excess of 56°F at the same compliance locations between Balls Ferry and Bend

Bridge from October 1 through October 31 to protect spring-run Chinook salmon.

Before 1997, to help meet the needs of federally listed winter-run Chinook salmon, cold water was released from low outlets at Shasta Dam. These cold-water releases bypassed hydropower facilities, causing the loss of power revenues. To achieve water temperature objectives in the Sacramento River without interrupting power generation, Reclamation constructed a temperature control device (TCD) on Shasta Dam that became operational in 1997. The TCD allows selective withdrawal of water from different reservoir depths without bypassing power generation, provides flexibility to Shasta Dam operations, and allows downstream temperature goals to be consistently achieved.

Historical Sacramento River water temperatures below Shasta Dam were analyzed from January 1991 through December 2005. The data set indicates that average temperatures vary seasonally, ranging from 47.9°F in February to 55.7°F in November. Water temperatures below Keswick Dam were analyzed for January 1990 through December 2006. Like the temperatures below Shasta Dam, average temperatures below Keswick Dam vary seasonally, ranging from 47.8°F in February to 54.9°F in November. Summer and fall temperatures typically increase by about 7°F. Water temperatures just downstream from Keswick Dam are influenced by releases from Shasta Lake and Whiskeytown Reservoir and Keswick Dam operations.

Lower Sacramento River and Delta

Water temperature in the Sacramento River at Colusa varies seasonally, ranging from 47.5°F to 67.5°F. Water temperatures gradually increase through the spring and summer and reach an average of about 65°F. Water temperature in the Sacramento River at Freeport varies seasonally, ranging from 48.7°F to 72.1°F (USGS 2000a).

Water temperature in the Delta is influenced only slightly by water management activities (i.e., dam releases) (Reclamation and DWR 2005). The 2004 and 2009 BOs for Sacramento River winter-run Chinook salmon are among the most influential factors governing Shasta releases, in terms of both quantity and timing (NMFS 2004, 2009). The BOs set temperature requirements below Keswick Dam for April through October. In years when CVP facilities cannot be operated to meet required temperature and storage objectives, Reclamation reinitiates consultation with NMFS (NMFS 2009).

CVP/SWP Service Areas

Water quality in the CVP and SWP service areas, including water temperature, is affected by fluctuations of water quality in the Delta, which in turn are influenced by water quality in the San Joaquin River, CVP and SWP export pumping rates, local agricultural diversions and drainage water, and the Sacramento River (CALFED 2000c).

7.1.4 Metals

Shasta Lake and Vicinity

Certain areas of Shasta Lake have been identified as impaired by toxic metal pollutants. For this reason, Shasta Lake is listed on the EPA's Section 303(d) list of impaired water bodies. For water bodies on the Section 303(d) list, the CWA requires the development of TMDL allocations for the pollutants of concern. A TMDL allocation must estimate the total maximum daily load, with seasonal variations and a margin of safety, for all suitable pollutants and thermal loads, at a level that would ensure protection and propagation of a balanced population of indigenous fish, shellfish, and wildlife. Table 7-2 shows the potential sources of pollution within specific areas of Shasta Lake, along with the TMDL priority and the estimated affected area of the pollutants.

Table 7-2. CWA Section 303(d) List of Water Quality Limited Segments, Shasta Lake, 2010

Pollutant	Potential Sources	TMDL Priority	Estimated Area Affected
Horse Creek, Town Creek, and Little Backbone Creek			
Cadmium	Resource extraction	Low	1.50 miles
Copper	Resource extraction	Low	1.50 miles
Lead	Resource extraction	Low	1.50 miles
Zinc	Resource extraction	Low	1.50 miles
All of Shasta Lake			
Mercury	Resource Extraction	Low	430 Miles
Area where West Squaw Creek enters Squaw Creek Arm of Shasta Lake			
Cadmium	Resource extraction	Low	20 acres
Copper	Resource extraction	Low	20 acres
Zinc	Resource extraction	Low	20 acres

Source: State Water Board 2006a

Key:
TMDL = total maximum daily load

Waters discharged by stream channels draining the areas disturbed by the mining of sulfide ore deposits are generally acidic and contain high concentrations of dissolved metals, including iron, copper, and zinc. The streams with the highest metal concentrations are Flat Creek (below Shasta Dam), Little Backbone Creek, Spring Creek (below Shasta Dam), West Squaw Creek, Horse Creek, and Zinc Creek (USGS 1978). Dissolved metals concentrations discharged by these streams violate water quality objectives and fish kills occur periodically, primarily during periods of high rainfall runoff (CVRWQCB 2003b) . The sources of the metals are surface and groundwater discharge from underground mines and waters flowing through open pits, tunnels, mine tailing deposits, waste rock, and Quaternary deposits that include modern alluvium along the shoreline. Interaction with sulfide minerals and erosion of metal-rich material commonly result in low pH readings and high metal concentrations.

The sources of the metals in the two areas identified in Table 7-2 are associated with the Bully Hill/Rising Star mining complex adjacent to West Squaw Creek. Although these mines are no longer operational and remedial action continues, these areas are a documented source of metals and continue to be subject to an abatement order issued by the CVRWQCB. A containment structure constructed sometime during the early 1900s has filled with sediment downstream from the Bully Hill Mine. No information is available on the character of the material stored behind this earth fill dam. In 2006, North State Resources, Inc., conducted a Phase 1 Site Assessment of sediment deposits at two isolated locations in a cove over a small divide from the Bully Hill Mine. This assessment documented elevated levels of sulfide minerals in these sediment deposits and extremely low pH values in surface waters draining this deposit of sediment (NSR 2007).

Tributaries to the Main Body of Shasta Lake are also a source of metals, along with acid mine drainage from a number of mines in the West Squaw Creek and Little Backbone Creek watersheds. In addition to runoff from the historic workings (i.e., adits and portals), a number of large mine tailing deposits are currently leaching various metals into tributaries to Shasta Lake (CVRWQCB 2003a).

Between 2002 and 2003, the CVRWQCB conducted an investigation intended to increase the understanding of the relationship between elevated metal concentrations (dissolved copper and zinc) in discharges from Shasta Dam and the temporal and spatial distribution of these metals within and upslope of Shasta Lake (CVRWQCB 2003a). Specifically, this investigation attempted to answer two questions:

- Why do these elevated metal concentrations appear seasonally?
- Are the concentrations somehow related to the operation of the TCD that is attached to the upstream face of Shasta Dam?

In 2003, the CVRWQCB issued an interim report that provided data and limited analysis at 17 sites upstream from Shasta Dam. The data set included 412 discrete samples and included 1,043 specific chemical analyses for various chemical constituents (CVRWQCB 2003b). The interim report offers the following conclusion: “This study shows a direct correlation between dissolved copper concentrations in the upper water column near the dam and dissolved copper concentrations immediately downstream from the dam in the winter months.” The report goes on to suggest that this correlation may somehow be related to the operation of the TCD as it relates to the seasonal thermocline that develops in Shasta Lake (CVRWQCB 2003b).

Upper Sacramento River (Shasta Dam to Red Bluff)

A major source of metals to the Sacramento River is drainage from inactive mines in the Iron Mountain area of the West Shasta mining district. During mining and smelting activities from the 1880s to the 1960s, Iron Mountain's acid mine drainage discharged directly to Spring Creek, a Sacramento River tributary upstream from Redding (USGS 2000b).

USGS conducted a water quality assessment of trace metal concentrations in the Sacramento River at Big Bend above Red Bluff from February 1996 to May 1998 (USGS 2000b). Although metals concentrations are a serious water quality concern in the project area, metals did not exceed water quality objectives during the study period.

The CVRWQCB has determined that the 25-mile segment of the upper Sacramento River between Keswick Dam and Cottonwood Creek near Balls Ferry in Shasta County is impaired because of levels of dissolved cadmium, copper, and zinc that exceed water quality standards (CVRWQCB 2002). The impairment results primarily from inactive mines in the upper Sacramento River watershed, predominantly the Iron Mountain site upstream from Keswick Dam and other mines upstream from Shasta Dam.

Water quality enhancement actions at the mines and improved coordination of the Spring Creek and Keswick Reservoirs have resulted in a notable decrease in the number of water quality targets exceeded in the past 10 years. However, metal loading remains high enough to cause periodic exceedences (CVRWQCB 2002). The sediments found in the Spring Creek Arm of Keswick Reservoir contain high levels of copper and zinc, which settled out of the contaminated stormwater runoff from the Iron Mountain Mine Superfund site. In 2009 and 2010, EPA dredged and removed contaminated sediments at this location with the goal of protecting the downstream Sacramento River ecosystem during storm events, when contaminated sediments can become mobilized and carried downstream. EPA expects that dredging the contaminated sediments will eliminate the last major threat that contamination from the Iron Mountain Mine poses to human health and the environment (EPA 2009).

High mercury concentrations in the Sacramento River correlate with concentrations of suspended sediment and high flows, because much of the mercury is transported adsorbed to suspended sediments (Domagalski et al. 2000). In May 2000, EPA adopted a water quality objective for total mercury for the Sacramento River watershed of 50 nanograms per liter (30-day average). In a USGS study of mercury levels along the Sacramento River at Big Bend above Red Bluff, conducted from February 1996 to May 1998, mercury levels were consistently below the EPA criterion of 50 nanograms per liter (USGS 2000b).

Lower Sacramento River and Delta

The downstream tributaries Cache Creek and Putah Creek are known to be substantial sources of mercury to the Sacramento River. The Sacramento River from Knights Landing to the Delta is listed as impaired on EPA's 303(d) list for mercury (CVRWQCB 2002).

The Delta waterways within the area under the CVRWQCB's jurisdiction are listed on EPA's 303(d) list as impaired for mercury from agriculture and historic mining, while the western Delta, under the jurisdiction of the San Francisco Bay RWQCB, is listed as impaired for mercury, nickel, and selenium. The primary sources of mercury are abandoned mine sites in the upper watershed that drain into the lower Sacramento River and Delta. The City of Sacramento is also the largest urban source of nitrogen, mercury, and assorted other urban waste products. Selenium concentrations are attributed to agriculture and oil refiners, while the primary source of nickel is unknown (State Water Board 2006a).

CVP/SWP Service Areas

Water quality in the CVP and SWP service areas is affected by fluctuations of water quality in the south Delta, which in turn are influenced by water quality in the San Joaquin River, CVP and SWP export pumping rates, local agricultural diversions and drainage water, and the Sacramento River (CALFED 2000c).

7.1.5 Salinity

The following discussion of the affected environment in the study area with regard to salinity is limited to a discussion of conditions in the lower Sacramento River and Delta portion of the extended study area because of the potential effects of salinity in this geographic area on beneficial uses. Salinity is particularly important in the Delta, which is influenced by tidal exchange with San Francisco Bay; during low-flow periods, seawater intrusion results in increased salinity.

Lower Sacramento River and Delta

The following are recognized water quality issues in the Delta (Reclamation and DWR 2005):

- High salinity from Suisun Bay intrudes into the Delta during periods of low Delta outflow. Salinity can adversely affect agricultural, M&I, and recreational uses.

- Delta exports contain elevated concentrations of disinfection byproduct precursors (e.g., dissolved organic carbon), and the presence of bromide increases the potential for formation of brominated compounds in treated drinking water.

- Agricultural drainage in the Delta contains high levels of nutrients, suspended solids, dissolved organic carbon and minerals (salinity), and agricultural chemicals (pesticides).
- Synthetic organic chemicals and heavy metals have bioaccumulated in Delta fish and other aquatic organisms, occasionally exceeding standards for food consumption.
- The San Joaquin River inflow to the Delta is typically lower quality than Delta inflow from other tributary sources such as the Sacramento River. Because the south Delta receives a substantial portion of water from the San Joaquin River, the influence of this relatively poor San Joaquin River water quality is greatest in the south Delta channels and in CVP and SWP exports.

Trends in Delta water quality reflect the effects of river inflows, tidal exchanges with San Francisco Bay, diversions, and pollutant releases. The north Delta tends to have better water quality primarily because of inflow from the Sacramento River. The quality of water in the west Delta is strongly influenced by tidal exchange with San Francisco Bay; during low-flow periods, seawater intrusion results in increased salinity. In the south Delta, water quality tends to be poorer because of the combination of inflows of poorer water quality from the San Joaquin River, discharges from Delta islands, export pumping, seasonal agricultural barriers, and effects of diversions that can sometimes increase seawater intrusion from San Francisco Bay.

The Sacramento and San Joaquin rivers contribute approximately 61 percent and 33 percent, respectively, to TDS concentrations within the Delta from tributary inflows. TDS concentrations are relatively low in the Sacramento River, but because of its large volumetric contribution, the river provides the majority of the TDS load supplied by tributary inflow to the Delta (DWR 2001). Although actual flow from the San Joaquin River is lower than flow from the Sacramento River, TDS concentrations in San Joaquin River water average approximately seven times the TDS concentrations in the Sacramento River.

7.2 Regulatory Framework

Several regulatory authorities at the Federal, State of California (State), and local levels control the flow, quality, and supply of water in California either directly or indirectly. This section focuses on laws related directly to the water quality aspect of the project.

Management of the Delta is partly determined by Federal and State regulations developed to protect both human and environmental beneficial uses. Primary institutional and regulatory influences on the use and management of the Delta consist of the CVP; the SWP; direct Delta diverters, including Contra Costa

Water District (CCWD), Solano County Water Agency, and the City of Stockton Metropolitan Area; San Francisco Bay water quality needs; and multiple regulations governing protection of endangered species.

At the State level, the State Water Board and the RWQCBs regulate and monitor Delta water quality. Nine regional boards oversee water quality in California. Two of these, the CVRWQCB and San Francisco Bay RWQCB, oversee Delta water quality. EPA also plays an important role under the auspices of the CWA and the Safe Drinking Water Act (SDWA). The California Department of Public Health has an interest in the Delta because the Delta is the source of drinking water for more than 23 million Californians. DWR extensively monitors Delta water quality as part of its Municipal Water Quality Investigations program; in cooperation with Reclamation, DWR monitors Delta water quality under the State Water Board's compliance monitoring requirements.

At the local level, water agencies that divert from the Delta have both strong interest in and influence on Delta water quality management. These agencies include CCWD, Solano County Water Agency, and City of Stockton Metropolitan Area.

Two agencies with key planning roles in the Delta are the California Bay-Delta Authority and the Delta Protection Commission. The California Bay-Delta Authority became a State agency in January 2003, and is responsible for implementing the CALFED Bay-Delta Program (CALFED). State legislation created the Delta Protection Commission in 1992 with the goal of developing regional policies for the Delta to protect and enhance existing land uses. In 2000, the commission was made a permanent State agency. The Delta Protection Commission comments on applications for CALFED ecosystem restoration grants that affect the Delta and participates in meetings with other CALFED agencies to provide input to CALFED management decisions.

7.2.1 Federal

Safe Drinking Water Act

The SDWA was established to protect the quality of drinking water in the United States. The SDWA authorized EPA to set national health-based standards for drinking water and requires many actions to protect drinking water and its sources, including rivers, lakes, reservoirs, springs, and groundwater wells. Furthermore, the SDWA requires all owners or operators of public water systems to comply with primary (health-related) standards. EPA has delegated to the California Department of Public Health, Division of Drinking Water and Environmental Management, the responsibility for administering California's drinking-water program. The California Department of Public Health is accountable to EPA for program implementation and for adopting standards and regulations that are at least as stringent as those developed by EPA. Contaminants of concern relevant to domestic water supply are defined as those that pose a public health threat or that alter the aesthetic acceptability of the water. These types of contaminants are regulated by EPA primary and secondary maximum contaminant levels that are applicable to treated water supplies delivered to the distribution system. Maximum contaminant levels and the process for setting these standards are reviewed triennially.

Clean Water Act

The CWA is the major Federal legislation governing the water quality aspects of the project. The objective of the act is "to restore and maintain the chemical, physical, and biological integrity of the nation's waters." The CWA establishes the basic structure for regulating discharge of pollutants into the waters of the United States and gives EPA the authority to implement pollution control programs such as setting wastewater standards for industries. In certain states such as California, EPA has delegated authority to state agencies.

Section 303 This section of the CWA requires states to adopt water quality standards for all surface waters of the United States. The three major components of water quality standards are as follows:

- **Designated uses** – Uses that society, through the Federal and State governments, determines should be attained in the water body, such as supporting communities of aquatic life, supplying water for drinking, irrigating crops and landscaping, and industrial purposes, and recreational uses (e.g., fishing, swimming, boating).

- **Water quality criteria** – Levels of individual pollutants or water quality characteristics, or descriptions of conditions of a water body that, if met, will generally protect the designated use of the water. Water quality criteria must be scientifically consistent with attainment of designated uses, which means that only scientific considerations can be taken into account when determining what water quality conditions are consistent with meeting a given designated use. Economic and social impacts are not considered when developing water quality criteria.

- **Antidegradation policy** – Designed to prevent deterioration of existing levels of good water quality (see the "Antidegradation Policy" section below for more information).

Where multiple uses exist, water quality standards must protect the most sensitive use. In California, EPA has given the State Water Board and its nine RWQCBs the authority to identify beneficial uses and adopt applicable water quality objectives.

Section 303(d) of the CWA requires states and authorized Native American tribes to develop a list of water quality-impaired segments of waterways. The list includes waters that do not meet water quality standards necessary to support the beneficial uses of that waterway, even after point sources of pollution have installed the minimum required levels of pollution control technology. Only waters impaired by "pollutants," not those impaired by other types of "pollution" (e.g., altered flow and/or channel modification), are to be included on the list. (Pollutants include clean sediments, nutrients (e.g., nitrogen and phosphorus), pathogens, acids/bases, temperature, metals, cyanide, and synthetic organic chemicals.)

Section 303(d) of the CWA also requires states to maintain a listing of impaired water bodies so that a TMDL can be established. A TMDL is a plan to restore the beneficial uses of a stream or to otherwise correct an impairment. It establishes the allowable pollutant loadings or other quantifiable parameters (e.g., pH or temperature) for a water body and thereby provides the basis for the establishment of water quality-based controls. The calculation for establishment of TMDLs for each water body must include a margin of safety to ensure that the water body can be used for the purposes the State has designated. Additionally, the calculation also must account for seasonal variation in water quality. The CVRWQCB develops TMDLs for the Sacramento River (see discussion on the Porter-Cologne Water Quality Control Act (Porter-Cologne Act) below). Sedimentation/siltation impacts are the primary water quality parameters of concern with construction projects.

Reductions in pollutant loading are achieved by implementing strategies authorized by the CWA, such as the following, which are discussed in more detail below.

- **Section 401** – This section of the CWA requires Federal agencies to obtain certification from the State or Native American tribes before issuing permits that would result in increased pollutant loads to a water body. The certification is issued only if such increased loads would not cause or contribute to exceedences of water quality standards.

- **Section 402** – This section creates the National Pollutant Discharge Elimination System (NPDES) permit program. This program covers point sources of pollution discharging into a surface water body.

- **Section 404** – This section regulates the placement of dredged or fill materials into wetlands and other waters of the United States.

Section 401 – Water Quality Certification This section of the CWA requires an applicant for any Federal license or permit (e.g., a Section 404 permit) that may result in a discharge into waters of the United States to obtain a certification from the State that the discharge would comply with provisions of the CWA. The State Water Board and RWQCBs administer this program. The State Water Board issues Section 401 certifications for projects that would take place in two or more regions. Any condition of a Section 401 certification (or water quality certification) would be incorporated into the USACE permit.

The CVRWQCB has jurisdiction over the primary study area, but the extended study area encompasses the San Francisco Bay, Central Coast, Los Angeles, Lahontan, Colorado River basin, and the Santa Ana and San Diego RWQCBs. A Section 401 certification would not be required from the RWQCBs within the extended study area because no construction would occur in the extended study area.

Section 402 – National Pollutant Discharge Elimination System All point sources that discharge into waters of the United States must obtain an NPDES permit under provisions of Section 402 of the CWA. As with Section 401, the State Water Board and RWQCBs are responsible for implementing the NPDES permitting process at the State and regional levels, respectively.

The NPDES permit process also provides a regulatory mechanism for controlling nonpoint-source pollution created by runoff from construction and industrial activities, and general and urban land use, including runoff from streets. Projects involving construction activities (e.g., clearing, grading, or excavation) involving land disturbance greater than one acre must file a notice of intent with the appropriate RWQCB(s) to indicate their intent to comply with the General Permit for Discharges of Stormwater Associated with Construction Activity (Construction General Permit Order 2009-0009-DWQ, which went into effect and replaced Order 99-08-DWQ on July 1, 2010). This general permit establishes conditions to minimize sediment and pollutant loadings and requires preparation and implementation of a Stormwater Pollution Prevention Plan (SWPPP) before construction. The SWPPP is intended to help identify the sources of sediment and other pollutants, and to establish best management practices (BMP) for stormwater and nonstormwater source control and pollutant control. A sediment monitoring plan must be included in the SWPPP if the discharges occur directly to a water body listed on the Section 303(d) TMDL list for sediment.

The CVRWQCB has jurisdiction over the primary study area. A NPDES permit would not be required from the RWQCBs within the extended study area because no construction would occur in the extended study area.

Section 404 – Discharge of Dredged or Fill Material into Waters of the United States Section 404 deals with one broad type of pollution – the placement of dredged or fill material into "waters of the United States." Jurisdictional limits of these features are typically noted by the ordinary high-water mark. Isolated ponds or seasonal depressions had been previously regulated as waters of the United States. However, in *Solid Waste Agency of Northwestern Cook County v. United States Army Corps of Engineers et al.* (January 8, 2001), the U.S. Supreme Court ruled that certain "isolated" wetlands (e.g., nonnavigable, isolated, and intrastate) do not fall under the jurisdiction of the CWA and are no longer under USACE jurisdiction. (Although isolated wetlands may not be under Federal regulation, they are regulated by the State (see Porter-Cologne Act discussion below)). Some circuit courts (e.g., *U.S. v.*

Deaton, 2003; *U.S. v. Rapanos*, 2003; *Northern California River Watch v. City of Healdsburg*, 2006), however, have ruled that Solid Waste Agency of Northwestern Cook County does not prevent CWA jurisdiction if a "significant nexus" such as a hydrologic connection exists. The hydrologic connection may be human-made (e.g., roadside ditch) or a natural tributary to navigable waters, or direct seepage from the wetland to the navigable water through a surface or underground hydraulic connection. An ecological connection (e.g., the same bird, mammal, and fish populations are supported by both the wetland and the navigable water) and changes to chemical concentrations in the navigable water caused by water from the wetland may also constitute a significant nexus.

The discharge of dredge or fill generally includes the following activities:

- Placement of fill that is necessary for the construction of any structure or infrastructure in a water of the United States
- The building of any structure, infrastructure, or impoundment requiring rock, sand, dirt, or other material for its construction
- Site-development fills for recreational, industrial, commercial, residential, or other uses
- Causeways or road fills
- Dams and dikes
- Artificial islands
- Property protection and/or reclamation devices such as riprap, groins, seawalls, breakwaters, and revetments
- Beach nourishment
- Levees
- Fill for structures such as sewage treatment facilities, intake and outfall pipes associated with powerplants, and subaqueous utility lines
- Placement of fill material for construction or maintenance of any liner, berm, or other infrastructure associated with solid waste landfills
- Placement of overburden, slurry, mine tailing deposits, or similar mining-related materials
- Artificial reefs

USACE regulations and policies mandate avoiding the filling of wetlands unless it can be demonstrated that no practicable alternatives (to filling wetlands) exist.

Four basic processes exist for obtaining Section 404 authorization from USACE. Because of its scale and potential impact, this project would require an individual permit.

USACE's Sacramento District has jurisdiction over the primary study area, but the extended study area encompasses the San Francisco and Los Angeles Districts of USACE.

Antidegradation Policy

The Antidegradation Policy, established in 1968 and revised in 2005 (Title 40, Code of Federal Regulations, Section 131.12), is designed to protect existing uses and water quality and national water resources, as authorized by Section 303(c) of the CWA. At a minimum, the policy and implementation methods must be consistent with the following:

- Existing instream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected.
- Where the quality of the waters exceeds levels necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water, that quality shall be maintained and protected unless the State finds that allowing lower water quality is necessary to accommodate important economic or social development in the area in which the waters are located. In allowing such degradation or lower water quality, the State shall assure water quality adequate to protect existing uses fully. Further, the State shall assure that there shall be achieved the highest statutory and regulatory requirements for all new and existing point sources and all cost-effective and reasonable BMPs for nonpoint source control.
- Where high-quality waters constitute an outstanding National resource, such as waters of National and State parks and wildlife refuges and waters of exceptional recreational or ecological significance, that water quality shall be maintained and protected.

Although the quality of water in the upper Sacramento River is relatively good, water quality problems do occur, including the presence of mercury, pesticides such as organochlorine pesticides, trace metals, turbidity, and toxicity from unknown origin (CALFED 2000a).

The CWA requires states to maintain a listing of impaired water bodies so that a TMDL can be established. A TMDL is a plan to restore the beneficial uses of a stream or to otherwise correct an impairment. The most prevalent contaminants in the Sacramento River basin are for organophosphate pesticides (agricultural runoff) and trace metals (acid mine drainage), for which TMDLs currently are being considered. Only during conditions of stormwater-driven runoff are water quality objectives typically not met (Domagalski et al. 2000).

Shasta-Trinity National Forest Land and Resource Management Plan

STNF is guided by various laws, regulations, and policies that provide the framework for all levels of planning. These include regional guides, the STNF LRMP, and site-specific planning documents, such as this document.

The STNF LRMP provides guidance for managing NFS lands in STNF. The development of a forest LRMP occurs within the framework of regional and national USFS planning. The LRMP includes forest goals, forest objectives (including forest-wide prescription assignment by acres, outputs, and activities), and forest standards and guidelines. Forest goals state the management philosophy of the LRMP, and the Forest objectives describe the purpose of the management prescriptions. The forest-wide management prescriptions apply a management theme to specific types of land (e.g., wilderness, roaded high-density recreation).

In essence, this LRMP requires that projects authorized by STNF be designed and implemented in a manner that maintains the existing conditions or implements actions to restore biological and physical processes within their natural range of variability.

Water Quality Goals (LRMP, p. 4-6)

- Maintain or improve water quality and quantity to meet fish habitat requirements and domestic use needs.
- Maintain water quality to meet or exceed applicable standards and regulations.

Standards and Guidelines (LRMP, p. 4-25)

- Implement BMPs for protection or improvement of water quality, as described in "USFS Soil and Water Handbook for Region 5," for applicable management activities. Determine specific practices or techniques during project-level planning using information obtained from on-site soil, water, and geology investigations.

Best Management Practices

- STNF water quality BMPs were developed in compliance with USFS National Best Management Practices for Water Quality Management on National Forest Lands.
- STNF water quality BMPs were developed in compliance with the USFS Soil and Water Handbook for Region 5 that was updated in 2011. The following BMPs are applicable to the proposed action:

Road Building and Site Construction Standards and Guidelines (LRMP, Appendix E, pp. E-2 through E-3)

- General guidelines for the location and design of roads
- Erosion control plan
- Timing of construction activities
- Road slope stabilization (preventive practice)
- Road slope stabilization (administrative practice)
- Dispersion of subsurface drainage from cut and fill slopes
- Control of road drainage
- Construction of stable embankments
- Minimization of sidecast material
- Servicing and refueling equipment
- Control of construction in riparian management zones
- Controlling in-channel excavation
- Diversion of flows around construction sites
- Bridge and culvert installation
- Disposal of right-of-way and roadside debris
- Specifying riprap composition
- Maintenance of roads
- Road surface treatment to prevent loss of materials
- Traffic control during wet periods
- Surface erosion control at facility sites

Recreation Standards and Guidelines (LRMP, Appendix E, p. E-3)

- Documentation of water quality data
- Control of sanitation facilities
- Control of refuse disposal

- Protection of water quality within developed and dispersed recreation areas

Aquatic Conservation Strategy (LRMP, p. 4-53)

- Maintain and restore the distribution, diversity, and complexity of watershed- and landscape-scale features to ensure protection of the aquatic systems to which species, populations, and communities are uniquely adapted.

- Maintain and restore spatial and temporal connectivity within and between watersheds. Lateral, longitudinal, and drainage network connections include floodplains, wetlands, upslope areas, headwater tributaries, and intact refugia. These network connections must provide chemically and physically unobstructed routes to areas critical for fulfilling life history requirements of aquatic and riparian-dependent species.

- Maintain and restore the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations.

- Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. Water quality must remain within the range that maintains the biological, physical, and chemical integrity of the system and benefits survival, growth, reproduction, and migration of individuals composing aquatic and riparian communities.

- Maintain and restore the sediment regime under which aquatic ecosystems evolved. Elements of the sediment regime include the timing, volume, rate, and character of sediment input, storage, and transport.

- Maintain and restore instream flows sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of sediment, nutrient, and wood routing. The timing, magnitude, duration, and spatial distribution of peak, high, and low flows must be protected.

- Maintain and restore the timing, variability, and duration of floodplain inundation and water table elevation in meadows and wetlands.

- Maintain and restore the species composition and structural diversity of plant communities in riparian areas and wetlands to provide adequate summer and winter thermal regulation, nutrient filtering, appropriate rates of surface erosion, bank erosion, and channel migration and to supply amounts and distributions of coarse woody debris sufficient to sustain physical complexity and stability.

- Maintain and restore habitat to support well-distributed populations of native plant, invertebrate, and vertebrate riparian-dependent species.

U.S. Bureau of Land Management

The BLM's Resource Management Plan, which is its plan for managing Federal lands in Shasta County, was amended by the 1994 Record of Decision (ROD) for the Northwest Forest Plan (Final Supplemental EIS for Amendments to Forest Service and Bureau of Land Management Planning Documents within the Range of the Northern Spotted Owl). This amendment required preparation of Watershed Analysis before initiating BLM activities. As a party to the Northwest Forest Plan, BLM, like USFS, is also required to ensure that projects are consistent with the Aquatic Conservation Strategy.

Biological Opinions on the Long-term Central Valley Project and State Water Project Operations Criteria and Plan

Since 2004, NMFS and USFWS BOs regarding effects of the proposed Operations Criteria and Plan (OCAP) have been revised twice. On October 22, 2004, NMFS issued a BO regarding effects of the proposed OCAP for the CVP in coordination with the SWP on winter-run Chinook salmon, spring-run Chinook salmon, Central Valley steelhead, Southern Oregon/Northern California Coast Coho salmon, and Central California Coast steelhead and their designated critical habitat. On February 16, 2005, USFWS issued a BO regarding effects of the proposed OCAP on delta smelt. The 2004 and 1995 BOs supersede the prior BOs issued by NMFS and USFWS, and contain reasonable and prudent measures and terms and conditions that specify fisheries monitoring actions, spawning gravel augmentation, forecasting of deliverable water, management of cold-water supply within reservoirs, temperature monitoring, adaptive management processes to analyze annual cold-water management, minimization of flow fluctuations, passage at Red Bluff Diversion Dam, operation of gates in the Delta, fish screening at pumping facilities, and numerous other effects minimization measures. In response to litigation, the 2004 and 2005 BOs were remanded to NMFS and USFWS for revision, but were not vacated.

In August 2008, Reclamation reinitiated consultation with the fishery agencies based on the 2008 *Biological Assessment on the Continued Long-Term Operations of the CVP and SWP* (2008 Long-Term Operation BA). In December 2008, the USFWS issued the 2008 USFWS BO, finding that the long-term operations of the CVP and SWP would jeopardize the continued existence of the Delta smelt. In July 2009, NMFS issued the 2009 NMFS BO, finding that the same operations would jeopardize populations of listed salmonids, steelhead, green sturgeon and killer whales. Because both agencies made jeopardy determinations, both agencies included a Reasonable and Prudent Alternative (RPA) in their BOs.

In response to lawsuits challenging the 2008 and 2009 BOs, the District Court for the Eastern District of California (District Court) remanded the BOs to

USFWS and NMFS in 2010 and 2011, respectively. The District Court ordered USFWS and Reclamation to prepare a final BO and associated final NEPA document by December 1, 2013. Similarly, the District Court ordered NMFS and Reclamation to prepare a final BO and associated final NEPA document by February 1, 2016. These legal challenges may result in changes in CVP and SWP operational constraints, if the revised USFWS and NMFS BOs contain new or amended RPAs. Despite this uncertainty, the 2008 Long-Term Operation BA and the 2008 and 2009 BOs issued by the fishery agencies contain the current estimate of potential changes in water operations that could occur in the near future. Furthermore, it is anticipated that the final BOs issued by the resource agencies will contain similar RPAs.

7.2.2 State

Porter-Cologne Water Quality Control Act

The Porter-Cologne Act is California's statutory authority for the protection of water quality. Under the act, the State must adopt water quality policies, plans, and objectives protecting the State's waters for the use and enjoyment of the people. Obligations of the State Water Board and RWQCBs to adopt and periodically update their basin plans are set forth in the act. A basin plan identifies the designated beneficial uses for specific surface water and groundwater resources, applicable water quality objectives necessary to support the beneficial uses, and implementation programs that are established to maintain and protect water quality from degradation for each of the RWQCBs. The act also requires waste dischargers to notify the RWQCBs of their activities through the filing of reports of waste discharge and authorizes the State Water Board and RWQCBs to issue and enforce waste discharge requirements (WDR), NPDES permits, Section 401 water quality certifications, or other approvals. The RWQCBs also have authority to issue waivers to reports of waste discharge/WDRs for broad categories of "low threat" discharge activities that have minimal potential for adverse water quality effects when implemented according to prescribed terms and conditions.

The Basin Plan (originally published in 1998, last revised in October 2011) (CVRWQCB 2011) regulates waters of the State located within the primary study area. The Basin Plan covers an area including the Sacramento and San Joaquin river basins, involving an area bounded by the crests of the Sierra Nevada on the east and the Coast Ranges and Klamath Mountains on the west. The area covered in the Basin Plan extends some 400 miles, from the California/Oregon border southward to the headwaters of the San Joaquin River, encompassing a substantial portion of the extended study area. The beneficial uses of the Sacramento River are as follows (CVRWQCB 2011):

- Municipal and domestic supply
- Irrigation and stock watering

- Service supply
- Power
- Contact recreation and canoeing and rafting
- Other noncontact recreation
- Freshwater habitat (warm and cold)
- Migration habitat (warm and cold)
- Spawning habitat (warm and cold)
- Wildlife habitat
- Navigation

The Basin Plan recognizes Shasta Reservoir (i.e., Shasta Lake) as a discrete water body and identifies a number of specific beneficial uses:

- Municipal and domestic supply
- Agricultural supply
- Hydropower generation
- Water contact recreation
- Noncontact recreation
- Freshwater habitat (warm and cold)
- Spawning, reproduction, and/or early development
- Wildlife habitat

The CVRWQCB has also promulgated water quality objectives for all surface waters in the Sacramento and San Joaquin River basins (CVRWQCB 2011) for the following:

- Bacteria levels
- Biostimulatory substances
- Chemical constituents
- Color
- Dissolved oxygen
- Floating material
- Methylmercury
- Oil and grease
- pH
- Pesticides
- Radioactivity
- Salinity
- Sediment
- Settleable material
- Suspended material
- Tastes and odors
- Temperature
- Toxicity
- Turbidity

Primary Study Area The CVRWQCB determined that the 25-mile reach of the Sacramento River from Keswick Dam downstream to Cottonwood Creek is impaired because the water periodically contains levels of dissolved cadmium, copper, and zinc that exceed levels identified to protect aquatic organisms. Consequently, the CVRWQCB developed a TMDL program for dissolved cadmium, copper, and zinc loading into the upper Sacramento River because of these exceedences of water quality standards (CVRWQCB 2002) and has proposed implementing the water quality objectives listed in Table 7-3 as numeric targets for this TMDL. No other TMDLs have been finalized for this area (CVRWQCB 2007a).

Table 7-3. Proposed TMDL Numeric Targets for Dissolved Cadmium, Copper, and Zinc for a 25-Mile Segment of the Upper Sacramento River between Keswick Dam and Cottonwood Creek near Balls Ferry in Shasta County

Metals	Acute Numeric Target (µg/L)	Chronic Numeric Target (µg/L)
Cadmium	0.22	0.22
Copper	5.6	4.1
Zinc	16	16

Source: CVRWQCB 2002

Key:
µg/L = micrograms per liter
TMDL = total maximum daily load

Extended Study Area The Sacramento River downstream from RBPP was listed as an impaired water body under Section 303(d) of the CWA. The parameters of concern in this reach included diazinon, mercury, and unknown sources of toxicity (CVRWQCB 2003b). TMDLs under development for the Sacramento River are for diazinon, methylmercury, and chlorpyrifos (CVRWQCB 2007b). The extended study area encompasses the San Francisco, Central Coast, Los Angeles, Lahontan, Colorado River basin, and the Santa Ana and San Diego RWQCBs.

Clean Water Act Section 401 Water Quality Certification

The CVRWQCB, under the auspices of the State Water Board, requires that a project proponent obtain a CWA Section 401 water quality certification in conjunction with the Section 404 permits granted by USACE. Because the project would have the potential to affect water quality in Shasta Lake, the CVRWQCB is likely to impose water quality limitations on the project through WDRs. Reclamation will prepare and submit to the CVRWQCB a request for water quality certification before development of the project. A likely condition of the water quality certification is preparation of an erosion and sedimentation control plan and a spill prevention and containment plan.

Waste Discharge Permit

The CVRWQCB controls the discharge of wastes to surface waters from industrial processes or construction activities through the NPDES permit process. WDRs are established in the permit to protect beneficial uses. The CVRWQCB will require an application for a waste discharge permit for the project.

Industrial Stormwater General Permit

The Industrial Stormwater General Permit (General Industrial Permit) is an NPDES permit that regulates discharges associated with 10 broad categories of industrial activities. This permit requires implementation of management measures that will achieve the performance standard of best available technology economically achievable and best conventional pollutant control technology. This permit also requires development of a SWPPP and a monitoring plan. Through the SWPPP, sources of pollutants are to be identified and the means to manage the sources to reduce stormwater pollution are described.

Stormwater Pollution Prevention Plan

The General Industrial Permit includes provisions for developing a SWPPP to maximize the potential benefits of pollution prevention and sediment- and erosion-control measures at construction sites. Developing and implementing a SWPPP would provide Reclamation with the framework for reducing soil erosion and minimizing pollutants in stormwater during project construction.

Water Quality Control Plan for the Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California

The Water Quality Control Plan for the Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California (Thermal Plan) sets limits for "thermal waste" and "elevated temperature waste" discharged into coastal and interstate waters and enclosed bays and estuaries of California (State Water Board no date). Estuarine waters are considered to extend from "…a bay or the open ocean to the upstream limit of tidal action" (State Water Board no date). This definition includes the Delta as defined by Section 12220 of the California Water Code, as well as portions of the Sacramento River that are subject to tidal action. Generally, the Basin Plan defines temperature objectives in two parts (CVRWQCB 2011):

> *At no time or place shall the temperature of COLD or WARM intrastate waters be increased more than 5°F above natural receiving water temperature.*
>
> *The temperature shall not be elevated above 56°F in the reach from Keswick Dam to Hamilton City nor above 68°F in the reach from Hamilton City to the I Street Bridge during periods when temperature increases will be detrimental to the fishery.*

The first water quality standards for the Delta were adopted in May 1967, when the State Water Rights Board (predecessor to the State Water Board) released State Water Board Water Right Decision 1275 (D-1275), approving water rights for the SWP while setting agricultural salinity standards as terms and conditions. Since then, these requirements were changed in 1971 under State Water Board Water Right Decision 1379 (D-1379), and again in 1978 under State Water Board Water Right Decision 1485 and the Water Quality Control Plan (WQCP) for the Delta and Suisun Marsh (1978 WQCP). In May 1995, State Water Board adopted a new Bay-Delta WQCP, and it was implemented through State Water Board Revised Water Right Decision 1641 (RD-1641) in March 2000.

2006 Water Quality Control Plan[2]

The 2006 WQCP for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (State Water Board 2006b) established water quality control measures that contribute to the protection of beneficial uses in the Delta. The 2006 WQCP identified (1) beneficial uses of the Delta to be protected, (2) water quality objectives for the reasonable protection of beneficial uses, and (3) a program of implementation for achieving the water quality objectives. The 2006 WQCP superseded the WQCP for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary adopted in May 1995 (1995 Bay-Delta Plan or 1995 Plan) as well as the preceding plans that the 1995 WQCP superseded (including the original 1978 WQCP and 1991 amended WQCP). Amendments made as part of the December 15, 1994, Bay-Delta Accord committed the CVP and SWP to new Delta habitat objectives. Because these new beneficial objectives and water quality standards were more protective than those of the previous Water Right Decision 1485, the new objectives were adopted by amendment in 1995 through a Water Rights Order for operation of the CVP and SWP. One key feature of the 1995 WQCP was the estuarine habitat (X2) objectives for Suisun Bay and the western Delta. The X2 objective required specific daily or 14-day surface EC criteria, or 3-day averaged outflow requirements to be met for a certain number of days each month, February through June. These requirements were designed to provide improved shallow water habitat for fish species in spring. Because of the relationship between seawater intrusion and interior Delta water quality, the X2 criteria also improved water quality at Delta drinking water intakes. Other new elements of the 1995 WQCP included export-to-inflow ratios intended to reduce entrainment of fish at the export pumps, Delta Cross Channel gate closures, and San Joaquin River EC and flow standards. Further amendments in 2006 updated the program of implementation in the 1995 WQCP, including adding direction and recommendations to other agencies regarding activities that the agencies should take to assist in achieving the objectives; and included several commitments and recommendations for studies and other activities.

[2] The 2006 WQCP was updated in 2013 to reflect the plan amendments adopted up through July 2013. The 2006 WQCP was used to support the analysis included in this EIS; the 2013 WQCP updates do not change this analysis.

Water Right Decision 1641

RD-1641 and Water Rights Order 2001-05 contain the water right requirements to implement the 2006 WQCP. RD-1641 incorporates water right settlement agreements between Reclamation and DWR and certain water users in the Delta and upstream watersheds regarding contributions of flows to meet water quality objectives. However, Reclamation and/or DWR are responsible for ensuring that objectives are met in the Delta. RD-1641 also authorizes the CVP and SWP to use joint points of diversion (JPOD) in the south Delta, and recognizes the CALFED Operations Coordination Group process for operational flexibility in applying or relaxing certain protective standards. The additional exports allowed under the JPOD could result in additional degradation of water quality for water users in the south and central Delta. The JPOD also could affect water levels in the south Delta and endangered fish species.

In February 2006, the State Water Board issued notice to Reclamation and DWR that each agency is responsible for meeting the objectives in the interior south Delta, as described in RD-1641. The State Water Board order requires Reclamation and DWR to comply with a detailed plan and time schedule that will bring them into compliance with their respective permit and license requirements for meeting interior south Delta salinity objectives by July 1, 2009. The State Water Board order also revised the previously issued (July 1, 2005) Water Quality Response Plan approval governing Reclamation's and DWR's use of each other's respective point of diversion in the south Delta. Additionally, the order specifies that JPOD operations are authorized pursuant to the 1995 WQCP, and that Reclamation and DWR may conduct JPOD diversions, provided that both agencies are in compliance with all conditions of their respective water right permits and licenses at the time the JPOD diversions would occur (State Water Board 2006a).

Municipal and Industrial Water Quality Objectives

In the 1978 WQCP, the State Water Board set two objectives that it believed would provide reasonable protection for M&I beneficial uses of Delta waters from the effects of salinity intrusion. The first objective established a year-round maximum mean daily chloride concentration measured at five Delta intake facilities, including CCWD's Pumping Plant Number 1, of 250 mg/L for the reasonable protection of municipal beneficial uses. This objective was consistent with the EPA secondary maximum contaminant level for chloride of 250 mg/L, and is based only on aesthetic (taste) considerations. The second objective established a maximum mean daily chloride concentration of 150 mg/L (measured at either CCWD Pumping Plant No. 1 or the San Joaquin River at the Antioch water works intake) for the reasonable protection of industrial beneficial uses (specifically manufacture of cardboard boxes by Gaylord Container Corporation in Antioch). This requirement is in effect for a minimum of between 155 and 240 days each calendar year, depending on the water year type.

In the 1991 WQCP, the State Water Board reviewed the water quality objectives for M&I use contained in the 1978 WQCP, and reviewed potential new objectives for trihalomethanes and other disinfection byproducts, including bromides. The State Water Board concluded that technical information regarding trihalomethanes and other disinfection byproducts was not sufficient to set a scientifically sound objective. Accordingly, the State Water Board continued the existing objectives for chloride concentration, and until development of more information about these constituents, set a water quality "goal" for bromides of 0.15 mg/L (150 micrograms per liter). The State Water Board also noted that the 150 mg/L chloride objective was maintained in part because it provides ancillary protection for other M&I uses in the absence of objectives for trihalomethanes and other disinfection byproducts.

These objectives remained unchanged in the 1995 and 2006 WQCPs. The State Water Board and CVRWQCB basin plans specify water quality objectives to protect designated beneficial uses, including municipal drinking-water supply. The CVRWQCB is also currently developing a Central Valley drinking-water policy that may lead to regulations limiting the discharge of bromide, organic carbon, pathogens, and other drinking water constituents of concern. The CVRWQCB took the important step of adopting resolutions in July 2004 (Resolution No. R5-2004-0091) and July 2010 (Resolution No. R5-2010-0079), supporting development of the policy. Resolution No. R5-2010-0079 directed CVRWQCB staff to develop and bring a comprehensive drinking water policy to the board within 3 years (i.e., by 2013).

Coordinated Operations Agreement

The Coordinated Operations Agreement defines how Reclamation and DWR share their joint responsibility to meet Delta water quality standards and meet the water demands of senior water right holders. The Coordinated Operations Agreement defines the Delta as being in either "balanced water conditions" or "excess water conditions." Balanced conditions are periods when Delta inflows are just sufficient to meet water user demands within the Delta, outflow requirements for water quality and flow standards, and export demands. Under excess conditions, Delta outflow exceeds the flow required to meet the water quality and flow standards. Typically, the Delta is in balanced water conditions from June to November, and in excess water conditions from December through May. However, depending on the volume and timing of winter runoff, excess or balanced conditions may extend throughout the year.

7.2.3 Local

The primary study area is located within both Shasta and Tehama counties, while the extended study area includes the following counties: Glenn, Butte, Colusa, Sutter, Yolo, Yuba, Sacramento, Napa, Solano, San Francisco, Contra Costa, San Joaquin, Alameda, Santa Clara, Stanislaus, Santa Cruz, San Benito, Merced, Madera, Fresno, Tulare, King, Kern, Santa Barbara, Ventura, Los Angeles, San Bernardino, Orange, Riverside, San Diego, and Imperial. Each of these counties has a general plan that includes general policies to protect water quality, water supply, water resources, and watersheds. No specific local requirements are pertinent to this analysis.

Water quality protection measures are included in the *Shasta County General Plan*. The county's goal is to protect all aspects of water quality in the county. The county defines erosion and downstream sedimentation as geologic hazards that must be prevented as part of grading and site development. The Shasta County Grading Ordinance sets requirements for grading and erosion control, including prevention of sedimentation or damage to off-site property. Grading permits require a vested map and the following information:

- A detailed grading plan
- Geological studies, if the project is located within an area that is prone to mass-movement, or has highly erodible soils or other known geologic hazards
- Detailed drainage or flood control information as required by the Department of Public Works
- A final development plan, if the project is located in a zone or district that requires a final development plan
- A noise analysis, if the project is located in the vicinity of a high-noise-generating use

The water quality protection goal included in the Open Space and Conservation Element of the Tehama County General Plan (Tehama County 2009) is to ensure that water supplies are of sufficient quality and quality, now and into the future, to serve the needs of Tehama County (Goal OS-1). Policies in support of this goal include sound watershed management, protection of surface water quality and streamflows, and protection of groundwater quality through the minimization of erosion and prevention of intrusion of wastes into water supplies.

7.3 Environmental Consequences and Mitigation Measures

7.3.1 Methods and Assumptions

A combination of water quality monitoring data and computer modeling was used to aid in the evaluation of potential impacts of the alternatives on water quality. Anticipated construction practices and materials, location, and duration of construction were also evaluated.

To evaluate potential Delta water quality impacts, the analysis relied on quantitative modeling tools to simulate conditions that would be expected to occur under the SLWRI alternatives compared to the bases of comparison (i.e., existing conditions without project and future conditions without project). The analysis of potential impacts on water quality in the Delta includes an analysis of potential impacts on water quality for all in-Delta water users. Delta parameters used in the evaluation include simulated changes in X2 location, Delta outflow, export-to-inflow ratio, salinity, and chloride ion concentrations.

The water quality impact assessment focuses on EC, measured in millimhos per centimeter (mmhos/cm), and chloride ion concentration in mg/L, as indicators of Delta water quality because they are the primary water quality constituents most likely to be affected by changes in Delta outflow and pumping operations. EC also is the parameter for which considerable monitoring data are available, and which has been used to calibrate the modeling tools used to simulate Delta water quality conditions.

A suite of modeling tools was used to evaluate the potential impacts of existing conditions, and the No-Action and other SLWRI alternatives, on the Delta water quality of the project and to quantify potential benefits. The SLWRI 2012 Version CalSim-II model, which was developed in 2012 for SLWRI, was used to simulate CVP and SWP operations, determining the surface water flows, storages, and deliveries associated with each alternative. CalSim-II is a specific application of the Water Resources Integrated Modeling System (WRIMS) to simulate CVP and SWP water operations. A detailed description of CalSim-II is included in Chapter 2 of the Modeling Appendix. Delta Simulation Model 2 (DSM2) was used to simulate the hydrodynamics of the Delta, providing the data used in discussion of the water-quality-related impacts of each alternative. (A detailed description of DSM2 and the assumptions used in the SLWRI analysis are included in Chapter 7 of the Modeling Appendix.) Summaries of the analysis and modeling results are provided below. (More detailed results of the CalSim-II output can be found in Attachment 1 of the Modeling Appendix.) Attachment 17 of the Modeling Appendix contains more detailed DSM2 output.

To understand the effects of the alternatives under both existing and future conditions, each alternative was modeled using two different assumptions about level of development (i.e., 2005 and 2030) and compared to the appropriate baseline modeling results to determine the character and extent of impacts.

CalSim-II

CalSim-II is the application of the WRIMS software to the CVP/SWP. This application was jointly developed by Reclamation and DWR for planning studies relating to CVP/SWP operations. The primary purpose of CalSim-II is to evaluate the water supply reliability of the CVP and SWP at current or future levels of development (e.g., 2005, 2030), with and without various assumed future facilities, and with different modes of facility operations. Geographically, the model covers the drainage basin of the Delta, and CVP/SWP exports to the Bay Area, San Joaquin Valley, Central Coast, and Southern California.

CalSim-II typically simulates system operations for an 82-year period using a monthly time step. The model assumes that facilities, land use, water supply contracts, and regulatory requirements are constant over this period, representing a fixed level of development (e.g., 2005, 2030). The historical flow record of October 1921 to September 2003, adjusted for the influences of land use changes and upstream flow regulation, is used to represent the possible range of water supply conditions. Major Central Valley rivers, reservoirs, and CVP/SWP facilities are represented by a network of arcs and nodes. CalSim-II uses a mass balance approach to route water through this network. Simulated flows are mean flows for the month; reservoir storage volumes correspond to end-of-month storage.

CalSim-II models a complex and extensive set of regulatory standards and operations criteria. (Descriptions of both are contained in Chapter 2 of the Modeling Appendix.) The hydrologic analysis for this EIS used SLWRI 2012 Version CalSim-II model, which is the best available hydrological modeling tool, to approximate the changes in storage, flow, salinity, and reservoir system reoperation associated with the SLWRI alternatives. Although CalSim-II is the best available tool for simulating system-wide operations, the model also contains simplifying assumptions in its representation of the real system.

A general external review of the methodology, software, and applications of CalSim-II was conducted in 2003 (Close et al. 2003). An external review of the San Joaquin River Valley CalSim-II model was also conducted (Ford et al. 2006). Several limitations of the CalSim-II model were identified in these external reviews. The main limitations of the CalSim-II model are as follows:

- Model uses a monthly time step
- Accuracy of the inflow hydrology is uncertain:
  - Model lacks a fully explicit groundwater representation

Reclamation, DWR, and the external reviewers have identified the need for a comprehensive error and uncertainty analysis for various aspects of the CalSim-II model. DWR has issued a CalSim-II Model Sensitivity Analysis Study (DWR 2005), and Reclamation is currently embarking on a similar sensitivity and uncertainty analysis for the San Joaquin River basin. This information will improve understanding of the model results.

Despite these limitations, the monthly CalSim-II model results remain useful for comparative purposes. It is important to differentiate between “absolute” or “predictive” modeling applications and “comparative” applications. In “absolute” applications, the model is run once to predict a future outcome and errors or assumptions in formulation, system representation, data, operational criteria, etc., all contribute to total error or uncertainty in model results. In “comparative” applications, the model is run twice, once to represent a base condition (No-Action Alternative) and a second time with a specific change (project) to assess the change in the outcome because of the input change. In this mode (the mode used for this EIS), the difference between the two simulations is of principal importance. Potential errors or uncertainties that exist in the "no-project" simulation are also present in the "project" simulation such that their impacts are reduced when assessing the change in outcomes. The SLWRI analysis is a comparative analysis.

DSM2

DSM2 is a branched 1-dimensional model for simulation of hydrodynamics, water quality, and particle tracking in a network of riverine or estuarine channels (DWR 2002). The hydrodynamic module can simulate channel stage, flow, and water velocity. The water quality module can simulate the movement of both conservative and nonconservative constituents. The model is used by DWR to perform operational and planning studies of the Delta.

Impact analyses for planning studies of the Delta are typically performed for an 82-year period (1922 to 2003). In model simulations, EC is typically used as a surrogate for salinity. Results from CalSim-II are used to define Delta boundary inflows. CalSim-II-derived boundary inflows include the Sacramento River flow at Hood, San Joaquin River flow at Vernalis, inflow from the Yolo Bypass, and inflow from the eastside streams. In addition, Net Delta Outflow from CalSim-II is used to calculate the salinity boundary at Martinez.

Details of the model, including source codes and model performance, are available from the DWR Bay-Delta Office, Modeling Support Branch Web site (http://modeling.water.ca.gov/delta/models/dsm2/index.html). Documentation on model development is discussed in annual reports on Methodology for Flow and Salinity Estimates in the Sacramento-San Joaquin Delta and Suisun Marsh submitted to the State Water Board by the DWR Delta Modeling Section.

Sediment

The potential impacts from sediment in terms of erosion and geomorphology are analyzed in Chapter 4, "Geology, Geomorphology, Minerals, and Soils."

The Watershed Erosion Prediction Project (WEPP) developed for the USFS is a model that is physically-based and applies fundamentals of erosion mechanics including hydrology, hydraulics and plant science. WEPP was developed by several land grant universities and federal resource agencies to replace the Modified Universal Soil Loss Equation and the earlier Universal Soil Loss Equation. Completed work has been documented in several hundred graduate degree theses and dissertations, government technical reports and peer-review professional journals. Climate, topography, soil and vegetation management are the four input values in WEPP. Possible outputs include soil detachment and deposition for roads and hillslopes under a variety of vegetation management scenarios.

First-iteration WEPP simulations were completed to support the development of feasible mitigation measures related to erosion and water quality. Road and Disturbed WEPP simulate erosion under several scenarios for roads and hillslopes. These models predicted sediment transport and delivery for disturbed ground related to conceptual mitigation measures (e.g., road sediment reduction, fuels reduction) that would be implemented within the primary study area. Alternatives for mitigating erosion were developed using a simplified sediment budget approach to demonstrate the feasibility and relative value of various types of mitigation activities described in the "Preliminary Environmental Commitments and Mitigation Plan Appendix."

Temperature

The analysis presented in Chapter 6, "Hydrology, Hydraulics, and Water Management," assumed that the SLWRI alternatives would not alter existing operational rules or protocols and that there would be no formal changes to CVP or SWP operating criteria. Each action alternative would include storing some additional flows behind Shasta Dam during periods when the flows would have otherwise been released downstream. The resulting increase in storage would be used both to create an expanded cold-water pool (CWP), thus benefiting fisheries, and for subsequent release downstream when opportunities would exist to put the water to beneficial use.

HEC-5Q temperature modeling was used to simulate flow and temperature for the Sacramento River system above Red Bluff. This model was updated to better represent the upper Sacramento River system with an emphasis on operation of the Shasta TCD. CalSim-II results were used as flow inputs to the HEC-5Q model. Temperature results are presented in Chapter 11, "Fisheries and Aquatic Resources." The water quality impacts analysis for temperature based on those results is summarized below.

Metals

Water quality data available for Shasta Lake and its tributaries were used to assess the impacts related to the discharge of metals into Shasta Lake. Available monitoring data for the Sacramento River were used to assess the impacts of metals in Keswick Reservoir and the Sacramento River downstream.

7.3.2 Criteria for Determining Significance of Effects

An environmental document prepared to comply with NEPA must consider the context and intensity of the environmental effects that would be caused by, or result from, the proposed action. Under NEPA, the significance of an effect is used solely to determine whether an EIS must be prepared. An environmental document prepared to comply with CEQA must identify the potentially significant environmental effects of a proposed project. A "[s]ignificant effect on the environment" means a substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by the project" (State CEQA Guidelines, Section 15382). CEQA also requires that the environmental document propose feasible measures to avoid or substantially reduce significant environmental effects (State CEQA Guidelines, Section 15126.4(a)).

Overall Impact Indicators for Water Quality

The significance criteria described below were developed based on guidance provided by the State CEQA Guidelines for use in assessing potential impacts on water quality; they also consider the context and intensity of the environmental effects as required under NEPA. These significance criteria were applied to the qualitative assessment and quantitative modeling results and used to determine impact significance. The analysis of water quality impacts and benefits focuses on temperature, metals, and sediment, because they are important water quality constituents in the both the primary and extended study areas.

The impact significance criteria for Delta water quality variables that have regulatory objectives or numerical standards, such as those contained in the 2006 WQCP, are developed from the general considerations listed below.

Impacts of an alternative on water quality would be significant if project implementation would do any of the following:

- Violate existing water quality standards or otherwise substantially degrade water quality
- Result in substantial water quality changes that would adversely affect beneficial uses
- Result in substantive undesirable impacts on public health or environmental receptors

Significance statements are relative to both existing conditions (2005) and future conditions (2030) unless stated otherwise.

Impact Indicators for Delta Salinity

If changes in salinity within the Delta during months of increased pumping would result in an increase in salinity, relative to the basis of comparison, of sufficient frequency and magnitude over the long term to adversely affect designated beneficial uses, to increase the frequency that existing regulatory standards are exceeded, or to substantially degrade water quality at the locations below, then the impact would be considered significant:

- Sacramento River at Collinsville
- San Joaquin River at Jersey Point
- Sacramento River at Emmaton
- Old River at Rock Slough

- Delta-Mendota Canal at Jones Pumping Plant
- West Canal at mouth of the Clifton Court Forebay
- San Joaquin River at Vernalis
- Old River near Tracy Road Bridge
- Old River at Middle River
- San Joaquin River at Brandt Bridge

Figure 7-3 shows the major Delta islands, waterways, water quality control stations, and M&I intakes within the Delta.

Salinity Salinity-related water quality impacts associated with the operational component of the SLWRI alternatives were assessed at several locations in the Delta. EC was used as a surrogate for salinity. Using the assumptions discussed above, and detailed in Chapter 7 of the Modeling Appendix, the DSM2 model calculated changes in monthly mean EC values for the alternatives, relative to the bases of comparison. Monthly EC results were derived for an 82-year simulation period, extending from 1922 through 2003.

DSM2 model output was used to evaluate potential changes in salinity under the SWLRI alternatives, relative to the bases of comparison: changes equal to or greater than 5 percent in long-term monthly average EC values and average monthly EC values by water year type, and compliance with water quality standards, including the number of occurrences during which an EC compliance standard was met or exceeded.

Node ID	Description
1	Sacramento River at Rio Vista
2	Sacramento River at Emmaton
3	Sacramento River at Collinsville
4	Sacramento River at Chipps Island
5	Sacramento River at Port Chicago (Roe Island)
6	Old River near Middle River
7	Old River at Tracy Road Bridge
8	Delta Mendota Canal at Tracy Pumping Plant
9	West Canal at mouth of Clifton Court Forebay Intake
10	Old River at CCWD Los Vaqueros Intake
11	CCWD Proposed Alternative Intake
12	Middle River east of Victoria Island
13	Woodward Canal
14	Old River at Rock Slough
15	Contra Costa Canal at Pumping Plant #1
16	San Joaquin River near Vernalis
17	San Joaquin River at Brandt Bridge
18	San Joaquin River downstream of Calaveras River
19	Stockton Proposed Intake
20	San Joaquin River at Prisoners Point
21	San Joaquin River at San Andreas Landing
22	San Joaquin River at Jersey Point
23	San Joaquin River at Antioch Ship Channel
24	Mokelumne River at Terminous
25	Barker Slough at North Bay Aqueduct Intake
26	Head of Old River Barrier
27	Middle River Barrier
28	Grant Line Canal Barrier
29	Old River Barrier at Tracy Road Bridge

Figure 7-3. Major Delta Islands, Waterways, Water Quality Control Stations, and Municipal and Industrial Intakes

Changes in salinity were evaluated in the Delta during months of increased pumping under the alternatives, relative to the bases of comparison. Potential significant impacts could occur if salinity increases were of sufficient frequency and magnitude over the long term to adversely affect designated beneficial uses, to exceed existing regulatory standards, or to substantially degrade water quality.

Delta water quality is directly controlled by existing Delta water quality objectives (State Water Board 1995) for M&I, agricultural, and fish and wildlife uses that are incorporated in State Water Board RD-1641 (State Water Board 2000). The 2006 WQCP objectives vary with month and water year type. Also, the 2006 WQCP objectives may only apply for some months and at some locations.

Applicable EC objectives were evaluated for the agricultural diversion season of April through August at Emmaton and Jersey Point, and during the entire year at each of the CVP/SWP export locations and three south Delta locations. Increases in EC values that result in exceedence of the objective at specified locations in the Delta were considered to be significant water quality impacts. Monthly changes in EC values are also considered to be significant if they exceeded 10 percent of the applicable objective.

Impact Indicators for X2 Position

If a change in mean monthly position of X2, relative to the bases of comparison, would be of sufficient frequency and magnitude to adversely affect water quality, then it will be considered a significant impact.

The X2 parameter represents the geographical location of the 2 parts per thousand near-bottom salinity isohaline in the Delta, which is measured in distance upstream from the Golden Gate Bridge in Suisun Bay (Jassby et al. 1995). The location of the estuarine salinity gradient is regulated during the months of February through June by the location of the X2 objective in the 2006 WQCP. During this time period, the X2 location must remain downstream from the confluence of the Sacramento and San Joaquin rivers at Collinsville for the entire 5-month period. The X2 objective also specifies the number of days each month that that location of X2 must be downstream from Chipps Island or downstream from Roe Island (also referred to as the Port Chicago EC monitoring station).

Estuarine EC objectives (i.e., X2) specified in the 2006 WQCP are applicable at Chipps Island during February through June for most years. The maximum EC objective at Chipps Island is 2.640 mmhos/cm (corresponding to a 2 parts per thousand salinity at Chipps Island) and must be satisfied for a specified number of days each month, depending on the previous month's Eight River Index (a measure of runoff in the Sacramento and San Joaquin valleys).

7.3.3 Topics Eliminated from Further Consideration

The action alternatives include measures to remove or abandon on-site wastewater treatment facilities (e.g., septic tanks and/or drain fields) in conjunction with relocation activities. Several wastewater treatment packages will be developed to ensure that management of effluent from lakeshore developments is consistent with requirements of Federal, State, and local agencies. Only minor project-related effects on nutrients are expected to occur in either the primary study area or the extended study area; therefore, potential effects on the study areas related to nutrients are not discussed further in this EIS.

7.3.4 Direct and Indirect Effects

No-Action Alternative

Under the No-Action Alternative, the Federal Government would take reasonably foreseeable actions, as defined above, but would take no additional action toward implementing a specific plan to help increase anadromous fish survival in the upper Sacramento River, nor help address the growing water reliability issues in California. Shasta Dam would not be modified, and the CVP would continue operating similar to the existing condition. Changes in regulatory conditions and water supply demands would result in differences in flows on the Sacramento River and at the Delta between existing and future conditions.

Shasta Lake and Vicinity

Impact WQ-1 (No-Action): Temporary Construction-Related Sediment Effects on Shasta Lake and Its Tributaries that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses Under the No-Action Alternative, no construction activities would occur. Therefore, there would be no short-term increases in turbidity and suspended sediment in Shasta Lake and tributary streams that would cause violations of water quality standards or adversely affect beneficial uses. Ongoing impacts of sediment on beneficial uses would remain consistent with those that occur periodically under baseline conditions. No impact would occur. Mitigation is not required for the No-Action Alternative.

Impact WQ-2 (No-Action): Temporary Construction-Related Temperature Effects on Shasta Lake and Its Tributaries that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses Under the No-Action Alternative, no new facilities associated with raising Shasta Dam would be constructed; therefore, no short-term changes in the temperature regime of waters within Shasta Lake or its tributaries would occur. No impact would occur. Mitigation is not required for the No-Action Alternative.

Impact WQ-3 (No-Action): Temporary Construction-Related Metal Effects on Shasta Lake and Its Tributaries that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses Under the No-Action

Alternative, no new facilities associated with raising Shasta Dam would be constructed in the vicinity of Shasta Lake; therefore, no construction-related metal effects would occur in Shasta Lake or tributary streams that would cause violations of water quality standards or adversely affect beneficial uses. No impact would occur. Mitigation is not required for the No-Action Alternative.

Impact WQ-4 (No-Action): Long-Term Sediment Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in Shasta Lake or Its Tributaries Under the No-Action Alternative, the operation of Shasta Dam would continue to influence the amount and duration of exposed shoreline below the maximum elevation of the reservoir, and sediment would continue to periodically be transported into Shasta Lake from tributaries and subsequently remobilized to other locations within the water column. Therefore, sediment and turbidity would remain consistent with baseline conditions. No impact would occur. Mitigation is not required for the No-Action Alternative.

As described in Chapter 4, "Geology, Geomorphology, Minerals, and Soils," the shoreline would continue to erode, and impacts to beneficial uses, namely recreation and to some extent, the warm-water fishery along the shoreline of Shasta Lake, would be ongoing. In addition to active areas of shoreline erosion, sediment would continue to periodically be transported into Shasta Lake from tributaries as a result of other ongoing actions within the project area. Wave action and nearshore currents would continue to remobilize sediment that is typically visible as turbid plumes of water along portions of the shoreline. Sediment and turbidity would remain consistent with baseline conditions. No impact would occur. Mitigation is not required for the No-Action Alternative.

Impact WQ-5 (No-Action): Long-Term Temperature Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in Shasta Lake or Its Tributaries Under the No-Action Alternative, Shasta Dam would continue to be operated consistent with current regulatory requirements with respect to storage and release of water to the upper Sacramento River. Therefore, there would be no change in the temperature regime of waters within Shasta Lake or its tributaries. Periodic changes in water temperature on a seasonal or interannual basis would be consistent with those that occur under baseline conditions. No impact would occur. Mitigation is not required for the No-Action Alternative.

Reclamation operates the Shasta Dam TCD to manage water temperatures in the upper Sacramento River to (1) improve habitat for the endangered winter-run Chinook salmon and other threatened runs; (2) withdraw warmer surface water in the winter and spring to preserve cold-water storage for release during the temperature operation season; and (3) enable power generation to continue while controlling release temperatures, thereby eliminating the need to bypass the power plant penstocks via the low-level river outlets. Generally, to accomplish these temperature objectives during the temperature operation season, the TCD functions to select water temperatures in the 47°F to 52°F range. Therefore, a good index of the temperature-related benefits of the alternative is the volume of the CWP with a water temperature lower than 52°F at the end of April.

Under the No-Action Alternative, Shasta Dam would continue to be operated consistent with current regulatory requirements with respect to storage and release of water to the upper Sacramento River. As described in Chapter 6, “Hydrology, Hydraulics, and Water Management,” the temperature profile within Shasta Lake would not be changed under the No-Action Alternative. Therefore, there would be no change in the temperature regime of waters within Shasta Lake or its tributaries. Periodic changes in water temperature on a seasonal or interannual basis would be consistent with those that occur under baseline conditions. No impact would occur. Mitigation is not required for the No-Action Alternative.

Impact WQ-6 (No-Action): Long-Term Metals Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in Shasta Lake or Its Tributaries Under the No-Action Alternative, metal concentrations in the Main Body and the Squaw Creek Arm of Shasta Lake would continue to be within the range of variability that currently exists with respect to the ongoing discharge and potential storage of heavy metals associated with historic mining and smelting operations. Concentrations of metals, specifically copper and zinc that may persist within the water column of Shasta Lake would continue to remain in suspension at locations and levels similar to baseline conditions. Ongoing remediation of historic mining properties at locations in the Dry Creek, Little Backbone, Squaw Creek, and Horse Creek watersheds are anticipated to reduce the amount of acid mine drainage into Shasta Lake over time, thereby reducing metal concentrations in the water column. This impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact WQ-7 (No-Action): Temporary Construction-Related Sediment Effects on the Upper Sacramento River that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses Under the No-Action Alternative, no new facilities would be constructed at Shasta Lake; thus there would be no construction-related sediment effects on the upper Sacramento River that would cause violations of water quality standards or adversely affect beneficial uses. No impact would occur. Mitigation is not required for the No-Action Alternative.

Impact WQ-8 (No-Action): Temporary Construction-Related Temperature Effects on the Upper Sacramento River that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses Under the No-Action Alternative, no new facilities associated with raising Shasta Dam would be constructed; therefore, no short-term changes in the temperature regime of waters within the upper Sacramento River would occur. No impact would occur. Mitigation is not required for the No-Action Alternative.

Impact WQ-9 (No-Action): Temporary Construction-Related Metal Effects on the Upper Sacramento River that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses Under the No-Action Alternative, no new facilities associated with raising Shasta Dam would be constructed; therefore, no construction-related metal effects would occur in the upper Sacramento River that would cause violations of water quality standards or adversely affect beneficial uses. No impact would occur. Mitigation is not required for the No-Action Alternative.

Impact WQ-10 (No-Action): Long-Term Sediment Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Upper Sacramento River Under the No-Action Alternative, the operation of Shasta Dam would continue to influence the amount and duration of sediment transported from Shasta Lake into the upper Sacramento River. Analysis of flow modeling results indicates little change in flows on the upper Sacramento River between existing conditions and the future No-Action Alternative conditions. Therefore, sediment and turbidity would remain similar to baseline conditions. This impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Impact WQ-11 (No-Action): Long-Term Temperature Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Upper Sacramento River Under the No-Action Alternative, ongoing operations to meet existing regulatory requirements would be continued. The ability to comply with existing temperature requirements would not be improved. Analysis of temperature modeling results indicates little change in compliance with temperature objectives on the upper Sacramento River between existing conditions and the future No-Action Alternative conditions. This impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Impact WQ-12 (No-Action): Long-Term Metals Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Upper Sacramento River Under the No-Action Alternative, ongoing remediation of historic mining properties at locations in the Dry Creek, Little Backbone, Squaw Creek, and Horse Creek watersheds are anticipated to reduce the amount of acid mine drainage into Shasta Lake over time, thereby reducing metal concentrations in the water column. Therefore, no long-term metals effects would occur that would cause violations of water quality standards or adversely affect beneficial uses in the upper Sacramento River. This impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Lower Sacramento River and Delta and CVP/SWP Service Areas

Impact WQ-13 (No-Action): Temporary Construction-Related Sediment Effects on the Extended Study Area that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses Under the No-Action Alternative, no construction activities would occur. Therefore, there would be no short-term increases in turbidity and suspended sediment in the extended study area that would cause violations of water quality standards or adversely affect beneficial uses. Ongoing impacts of sediment on beneficial uses would remain consistent with those that occur periodically under baseline conditions. No impact would occur. Mitigation is not required for the No-Action Alternative.

Impact WQ-14 (No-Action): Temporary Construction-Related Temperature Effects on the Extended Study Area that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses Under the No-Action Alternative, no new facilities associated with raising Shasta Dam would be constructed; therefore, no short-term changes in the temperature regime of waters within the extended study area would occur. No impact would occur. Mitigation is not required for the No-Action Alternative.

Impact WQ-15 (No-Action): Temporary Construction-Related Metal Effects on the Extended Study Area that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses Under the No-Action Alternative, no new facilities associated with raising Shasta Dam would be constructed; therefore, no construction-related metal effects would occur in the extended study area that would cause violations of water quality standards or adversely affect beneficial uses. No impact would occur. Mitigation is not required for the No-Action Alternative.

Impact WQ-16 (No-Action): Long-Term Sediment Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Extended Study Area Modeling results have indicated that flows in the Sacramento River would change little between existing conditions and the future No-Action Alternative conditions. Therefore, under the No-Action Alternative, sediment and turbidity would remain similar to baseline conditions. This impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Impact WQ-17 (No-Action): Long-Term Temperature Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Extended Study Area Analysis of temperature modeling shows little to no change in compliance with temperature objectives on the upper Sacramento River. This suggests that there would be little or no changes in temperature in the extended study area as a result of the No-Action Alternative. This impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Impact WQ-18 (No-Action): Long-Term Metals Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Extended Study Area Under the No-Action Alternative, ongoing remediation of historic mining properties at locations in the Dry Creek, Little Backbone, Squaw Creek, and Horse Creek watersheds are anticipated to reduce the amount of acid mine drainage into Shasta Lake over time, thereby reducing metal concentrations in the water column. Therefore, no long-term metals effects would occur that would cause violations of water quality standards or adversely affect beneficial uses in the extended study area. This impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Salinity The No-Action Alternative would differ from the existing conditions primarily through changes in regulatory conditions and water supply demands. Potential impacts, which are evaluated below, include changes in the following:

- Delta salinity on the Sacramento River at Collinsville
- Delta salinity on the San Joaquin River at Jersey Point
- Delta salinity on the Sacramento River at Emmaton
- Delta salinity on the Old River at Rock Slough
- Delta water quality on the Delta-Mendota Canal at Jones Pumping Plant
- Delta water quality on the West Canal at the mouth of the Clifton Court Forebay
- Delta salinity on the San Joaquin River at Vernalis
- Delta salinity on the San Joaquin River at Brandt Bridge
- Delta salinity on the Old River near the Middle River
- Delta salinity on the Old River at Tracy Road Bridge
- X2 position

Impact WQ-19a (No-Action): Delta Salinity on the Sacramento River at Collinsville The No-Action Alternative would result in both increases and decreases in salinity in comparison with baseline conditions; however, none of the increases would be sufficient to result in any violations of the salinity standards for the Sacramento River at Collinsville. On a percentage basis, all increases in salinity would be less than 6 percent. This impact would be less than significant. Mitigation is not required for the No-Action Alternative.

The water quality requirement on the Sacramento River at Collinsville is specified in RD-1641, and is defined for all year types,[3] from October through April. The RD-1641 objectives for the Sacramento River at Collinsville are defined in Table 7-4.

Table 7-4. RD-1641 Water Quality Objectives for the Sacramento River at Collinsville

Months	Year-Type	Value (mmhos/cm)
October	All	19.0
November–December	All	15.5
January	All	12.5
February–March	All	8.0
April–May	All	11.0

Source: State Water Board 2000

Notes:
Year types defined by Sacramento Valley Index.
The requirement is the maximum monthly average of daily high tide EC values or demonstration that equivalent or better protection will be provided at the location.

Key:
EC = electrical conductivity
mmhos/cm = millimhos per centimeter (unit of EC)
RD-1641 = Revised Water Right Decision 1641

As shown in Table 7-5, the No-Action Alternative would result in both increases and decreases in salinity as compared with baseline conditions; however, none of the increases would be sufficient to change compliance for the Sacramento River at Collinsville. On a percentage basis, all increases in salinity would be less than 6 percent. Table 7-6 shows the number of months simulated EC values exceeded the standards for the Sacramento River at Collinsville in the period of simulation. The No-Action Alternative would not result in any violations of the salinity standards for the Sacramento River at Collinsville. This impact would be less than significant. Mitigation is not required for the No-Action Alternative.

[3] Water year types are defined according to the Sacramento Valley Index Water Year Hydrologic Classification unless specified otherwise.

Table 7-5. Simulated Monthly Average Salinity and Percent Change for the Sacramento River at Collinsville Under the Existing Condition and No-Action Alternative

Month	Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	No-Action Alternative Change (mmhos/cm) (%))	Existing Condition (mmhos/cm)	No-Action Alternative Change (mmhos/cm (%))
October	6.0	0.0 (0.1%)	7.1	0.1 (1.0%)
November	5.1	0.0 (0.0%)	6.8	0.1 (1.6%)
December	3.6	0.0 (-1.1%)	5.5	0.0 (-0.5%)
January	1.8	-0.1 (-3.1%)	3.4	-0.1 (-3.3%)
February	0.8	0.0 (-3.1%)	1.7	-0.1 (-3.4%)
March	0.6	0.0 (-1.1%)	1.2	0.0 (-1.3%)
April	0.7	0.0 (0.9%)	1.4	0.0 (2.1%)
May	1.1	0.0 (3.9%)	2.3	0.1 (5.7%)
June	2.2	0.0 (2.1%)	4.0	0.1 (2.9%)
July	3.2	0.1 (2.2%)	5.3	0.2 (3.2%)
August	5.3	0.1 (1.1%)	7.3	0.1 (1.0%)
September	5.2	0.0 (0.2%)	8.8	0.0 (0.4%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAC081)

Note:
Simulation period: 1922–2003. Change as measured from Existing Condition. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
mmhos/cm = millimhos per centimeter

Table 7-6. Simulated Number of Months of Exceedence of the Salinity Standard for the Sacramento River at Collinsville Under the Existing Condition and No-Action Alternative

Month	Existing Condition (2005)			
	Total All Years		Dry and Critical Years	
	Existing Condition	No-Action Alternative Change	Existing Condition	No-Action Alternative Change
	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))
October	0	0.0 (0.0%)	0	0.0 (0.0%)
November	0	0.0 (0.0%)	0	0.0 (0.0%)
December	0	0.0 (0.0%)	0	0.0 (0.0%)
January	0	0.0 (0.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)
April	0	0.0 (0.0%)	0	0.0 (0.0%)
May	0	0.0 (0.0%)	0	0.0 (0.0%)
June	0	0.0 (0.0%)	0	0.0 (0.0%)
July	0	0.0 (0.0%)	0	0.0 (0.0%)
August	0	0.0 (0.0%)	0	0.0 (0.0%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAC081)

Note:

Simulation period: 1922–2003. Change as measured from Existing Condition. Dry and critical years as defined by the Sacramento Valley Index.

Key:

% = percent

Impact WQ-19b (No-Action): Delta Salinity on the San Joaquin River at Jersey Point The No-Action Alternative would result in both increases and decreases in salinity in comparison with baseline conditions; however, none of the increases would be sufficient to change compliance for the San Joaquin River at Jersey Point on a long-term basis. On a percentage basis, all increases in salinity would be less than 4 percent. This impact would be less than significant. Mitigation is not required for the No-Action Alternative.

The water quality requirement on the San Joaquin River at Jersey Point is specified in RD-1641 as two components. The first component of the requirement begins on April 1, and extends through a year-type-dependent date. The second component of the Jersey Point requirement begins at the end of the first component, and ends on August 15. The numerical requirement of the second component is dependent on the year type. Objectives for the San Joaquin River at Jersey Point are defined in Table 7-7.

Table 7-7. RD-1641 Water Quality Objectives for the San Joaquin River at Jersey Point

Year Type	0.45 EC April 1 to the Date Shown	EC from Date Shown to August 15 (mmhos/cm)
Wet	August 15	0.45
Above Normal	August 15	0.45
Below Normal	June 20	0.74
Dry	June 15	1.35
Critical	April 1	2.20

Source: State Water Board 2000

Note:
Year types defined by Sacramento Valley Index. Although requirement in RD-1641 is the maximum 14-day running average of mean daily EC, modeling uses a monthly average.

Key:
EC = electrical conductivity
mmhos/cm = millimhos per centimeter
RD-1641 = Revised Water Right Decision 1641

Table 7-8 shows simulated monthly average salinity and percent change for the San Joaquin River at Jersey Point. On an average monthly basis EC requirements would be satisfied in all months in an average year under the No-Action Alternative. Furthermore, all increases in EC during April through August would be less than 4 percent. Table 7-9 shows the number of months simulated EC values exceeded the standards for the San Joaquin River at Jersey Point in the period of simulation. The No-Action Alternative would result in an increase in the frequency of violations under existing conditions. Violations occur during June, July, and August and are greatest in August, when violations would be approximately 30 percent for all years and 38 percent during dry and critical years. The long-term and dry-year average EC values in April and May are found to be below the standards, which indicate the violation is marginal and does not show any significant changes in water quality. In June, the long-term average dry-year values would increase from 0.4 mmhos/cm to 0.5 mmhos/cm. In June of critical years and July of both dry and critical years, the long-term average would remain above the standards and would not change from the existing condition. In August and September of dry years, EC would decrease on a long-term average, and remain above the standards and unchanged in critical years.

Overall, the frequency of exceedence of salinity standards for the San Joaquin River at Jersey Point under the No-Action Alternative would be similar to those under existing and future conditions. This impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Table 7-8. Simulated Monthly Average Salinity and Percent Change for the San Joaquin River at Jersey Point Under the Existing Condition and No-Action Alternative

Month	Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	No-Action Alternative Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	No-Action Alternative Change (mmhos/cm (%))
October	1.6	0.0 (-0.9%)	1.8	0.0 (0.9%)
November	1.5	0.0 (-0.2%)	1.8	0.0 (2.4%)
December	1.2	0.0 (-1.0%)	1.8	0.0 (-0.6%)
January	0.7	0.0 (-4.0%)	1.1	-0.1 (-5.4%)
February	0.3	0.0 (-2.9%)	0.5	0.0 (-4.4%)
March	0.3	0.0 (-1.6%)	0.3	0.0 (-1.9%)
April	0.3	0.0 (-0.7%)	0.3	0.0 (0.8%)
May	0.3	0.0 (0.1%)	0.4	0.0 (3.9%)
June	0.4	0.0 (1.7%)	0.7	0.0 (3.7%)
July	1.0	0.0 (0.4%)	1.7	0.0 (0.5%)
August	1.6	0.0 (0.3%)	2.2	0.0 (-1.6%)
September	1.9	0.0 (0.8%)	2.8	0.0 (-0.6%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAN018)

Note:
Simulation period: 1922-2003. Change as measured from Existing Condition. Dry and critical years as defined by the Sacramento Valley Index.
Key:
% = percent
mmhos/cm = millimhos per centimeter

Table 7-9. Simulated Number of Months of Exceedence of the Salinity Standard for the San Joaquin River at Jersey Point Under the Existing Condition and No-Action Alternative

Month	Total All Years		Dry and Critical Years	
	Existing Condition	No-Action Alternative Change	Existing Condition	No-Action Alternative Change
	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))
October	0	0.0 (0.0%)	0	0.0 (0.0%)
November	0	0.0 (0.0%)	0	0.0 (0.0%)
December	0	0.0 (0.0%)	0	0.0 (0.0%)
January	0	0.0 (0.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)
April	0	0.0 (0.0%)	0	0.0 (0.0%)
May	0	0.0 (0.0%)	0	0.0 (0.0%)
June	10	3.0 (30.0%)	8	3.0 (37.5%)
July	51	-1.0 (-2.0%)	22	-1.0 (-4.5%)
August	73	3.0 (4.1%)	25	2.0 (8.0%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAN018)

Note:
Simulation period: 1922-2003. Change as measured from Existing Condition. Dry and critical years as defined by the Sacramento Valley Index.
Key:
% = percent

Impact WQ-19c (No-Action): Delta Salinity on the Sacramento River at Emmaton The No-Action Alternative would result in both increases and decreases in salinity in comparison to baseline conditions; however, changes in salinity would not affect compliance with the standard as the Delta is operated to meet water quality standards and would continue being operated to meet standards under the No-Action Alternative. This impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Similar to the water quality requirement on the San Joaquin River at Jersey Point, the water quality requirement on the Sacramento River at Emmaton is specified in RD-1641 as two components. The first component of the requirement begins on April 1, and extends through a year-type-dependent date. The second component of the Emmaton requirement begins at the end of the first component, and ends on August 15. The numerical requirement of the second component is dependent on the year type. Objectives for the Sacramento River at Emmaton are defined in Table 7-10.

Table 7-10. RD-1641 Water Quality Objective for the Sacramento River at Emmaton

Year Type	0.45 EC April 1 to the Date Shown	EC from Date Shown to August 15 (mmhos/cm)
Wet	August 15	0.45
Above Normal	July 1	0.63
Below Normal	June 20	1.14
Dry	June 15	1.67
Critical	April 1	2.78

Source: State Water Board 2000

Note:
Year types defined by Sacramento Valley Index. Although requirement in RD-1641 is the maximum 14-day running average of mean daily EC, modeling uses a monthly average.

Key:
EC = electrical conductivity
mmhos/cm = millimhos per centimeter
RD-1641 = Revised Water Right Decision 1641

Although Table 7-11 shows the EC for all months, the Emmaton water quality requirement is only defined for April 1 through August 15. On an average monthly basis, no change in the ability to meet EC requirements would occur in all months in an average year under the No-Action Alternative. Maximum change in monthly EC would not be greater than 6.8 percent. Table 7-12 shows the number of months simulated EC values exceeded the standards for the Sacramento River at Emmaton in the period of simulation. The No-Action Alternative would result in an increase in the frequency of violations under during April, May, and July of dry and critical years, and in July and August on average for all year types. The modeled potential violations shown in Table 7-12 are most likely caused by a mismatch between the CalSim-II operations model and the DSM2 Delta hydrodynamics and mixing model, and are not caused by water operations in the Delta. Modeled standards violations caused by mismatches between DSM2 and CalSim-II occur because CalSim-II's monthly time step is not well-suited to handling daily or 14-day standards, or running average standards that span more than 1 month, such as those evaluated here. Furthermore, CalSim-II uses empirical approximations for estimating Delta salinities that may not match the physically-based salinity calculations done in DSM2.The apparent violations in the model results are referred to as "potential violations" because they occur in the model but would not occur in actual operations. The Delta is operated to meet water quality standards and would continue being operated to meet standards under the No-Action Alternative.

Table 7-11. Simulated Monthly Average Salinity and Percent Change for the Sacramento River at Emmaton Under the Existing Condition and No-Action Alternative

Month	Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	No-Action Alternative Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	No-Action Alternative Change (mmhos/cm (%))
October	2.0	0.0 (1.0%)	2.4	0.1 (2.8%)
November	1.5	0.0 (0.8%)	2.2	0.1 (3.7%)
December	1.0	0.0 (-1.5%)	1.5	0.0 (-0.7%)
January	0.5	0.0 (-2.6%)	0.7	0.0 (-3.4%)
February	0.3	0.0 (-1.9%)	0.4	0.0 (-3.1%)
March	0.2	0.0 (-0.8%)	0.3	0.0 (-1.5%)
April	0.3	0.0 (0.9%)	0.3	0.0 (2.3%)
May	0.3	0.0 (3.7%)	0.5	0.0 (6.8%)
June	0.6	0.0 (2.2%)	1.1	0.0 (3.5%)
July	0.7	0.0 (4.4%)	1.3	0.1 (6.5%)
August	1.4	0.0 (2.1%)	2.3	0.1 (2.4%)
September	1.6	0.0 (1.2%)	3.0	0.1 (1.8%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAC092)

Note:

Simulation period: 1922–2003. Change as measured from Existing Condition. Dry and critical years as defined by the Sacramento Valley Index.

Key:

% = percent

mmhos/cm = millimhos per centimeter

Table 7-12. Simulated Number of Months of Exceedence of the Salinity Standard for the Sacramento River at Emmaton Under the Existing Condition and No-Action Alternative

Month	Total All Years		Dry and Critical Years	
	Existing Condition	No-Action Alternative Change	Existing Condition	No-Action Alternative Change
	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))
October	0	0.0 (0.0%)	0	0.0 (0.0%)
November	0	0.0 (0.0%)	0	0.0 (0.0%)
December	0	0.0 (0.0%)	0	0.0 (0.0%)
January	0	0.0 (0.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)
April	1	1.0 (100.0%)	1	1.0 (100.0%)
May	1	2.0 (200.0%)	1	2.0 (200.0%)
June	28	-1.0 (-3.6%)	18	1.0 (5.6%)
July	1	0.0 (0.0%)	1	0.0 (0.0%)
August	69	1.0 (1.4%)	26	0.0 (0.0%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAC092)

Note:
Simulation period: 1922-2003. Change as measured from Existing Condition. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent

Overall, the compliance of standards for the Sacramento River at Emmaton would be similar to the baseline levels under the No-Action Alternative. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-19d (No-Action): Delta Salinity on the Old River at Rock Slough
Under the No-Action Alternative, changes in chloride concentrations would not affect compliance with the standard as the Delta is operated to meet water quality standards and would continue being operated to meet standards under the No-Action Alternative. This impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Rock Slough is the location of the CCWD diversion for the Contra Costa Canal, but compliance with the salinity objectives is measured at Contra Costa Canal Pumping Plant No. 1. However, simulating water quality at Contra Costa Canal Pumping Plant No. 1 is difficult, and DSM2 does not explicitly simulate water quality at that location. Instead, a transfer function is applied to estimate the water quality at Contra Costa Canal Pumping Plant No. 1 based on the simulated water quality at Old River at Rock Slough from DSM2. The requirements, as defined in RD-1641, specify a minimum number of days during the calendar year that the maximum mean daily chloride concentration of

150 mg/L must be maintained. Objectives for the Contra Costa Canal Pumping Plant No. 1 are defined in Table 7-13.

Table 7-13. RD-1641 Water Quality Objective for Contra Costa Canal Pumping Plant No. 1

Year Type	Number of Days Each Calendar Year Chlorides Less Than or Equal to 150 mg/L
Wet	240
Above Normal	190
Below Normal	175
Dry	165
Critical	155

Source: State Water Board 2000

Note:
Year-types defined by Sacramento Valley Index.
Maximum mean daily 150 mg/L Cl- for at least the number of days shown.

Key:
RD-1641 = Revised Water Right Decision 1641
mg/L = milligram per liter

Table 7-14 shows simulated monthly average chloride concentrations and percent change for Contra Costa Canal Pumping Plant No. 1. On an average annual basis, the No-Action Alternative would not increase chloride concentrations by more than 10 percent. Maximum changes in chloride concentrations under the No-Action Alternative are less than 6.6 percent for dry and critical years.

Table 7-15 shows the average number of days in a year simulated chloride values exceeded the standard of 150 mg/L for Contra Costa Canal Pumping Plant No. 1. An increase in the number of potential daily violations of the chloride standard would occur under the No-Action Alternative as compared with the existing condition during the months of December through March, and July through September. As described for Impact WQ-19c (No-Action) for Table 7-12, the apparent violations shown in Table 7-15 are referred to as “potential violations” because they occur in the model but would not occur in actual operations. The Delta is operated to meet water quality standards and would continue being operated to meet standards under the No-Action Alternative. Overall, the No-Action Alternative would not alter the compliance level for Contra Costa Canal Pumping Plant No. 1. This impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Table 7-14. Simulated Monthly Average Chlorides and Percent Change for Contra Costa Canal Pumping Plant No. 1 Under the Existing Condition and No-Action Alternative

Month	Average All Years		Dry and Critical Years	
	Existing Condition (mg/L)	No-Action Alternative Change (mg/L (%))	Existing Condition (mg/L)	No-Action Alternative Change (mg/L (%))
October	156.2	0.8 (0.5%)	175.6	1.1 (0.6%)
November	154.9	0.5 (0.3%)	177.7	3.4 (1.9%)
December	144.3	7.4 (5.2%)	178.3	8.5 (4.7%)
January	153.9	11.0 (7.2%)	183.5	13.6 (7.4%)
February	106.2	13.0 (12.2%)	112.3	3.2 (2.8%)
March	95.2	8.6 (9.0%)	92.3	3.3 (3.5%)
April	88.4	1.6 (1.8%)	86.6	-1.2 (-1.4%)
May	90.4	-2.9 (-3.2%)	92.3	-5.1 (-5.5%)
June	62.4	-0.9 (-1.5%)	75.8	-0.3 (-0.4%)
July	73.8	2.8 (3.8%)	111.3	4.2 (3.8%)
August	117.0	5.0 (4.3%)	182.4	3.9 (2.2%)
September	158.5	8.6 (5.4%)	210.3	-1.8 (-0.9%)

*Source: Version 8.0.6, DSM2 Existing and Future simulations EC at Rock Slough (Node CHCCC006), converted to chlorides at Contra Costa Canal Pumping Plant No. 1 using the equation EC*0.268-24.*

Note:

Simulation period: 1922–2003. Change as measured from Existing Condition. Dry and critical years as defined by the Sacramento Valley Index.

Key:

% = percent mg/L = milligrams per liter

EC = electrical conductivity

Table 7-15. Simulated Number of Days by Month of Exceedence of the Chloride Standard for Contra Costa Canal Pumping Plant No. 1 Under the Existing Condition and No-Action Alternative

Month	Total All Years		Dry and Critical Years	
	Existing Condition	No-Action Alternative Change	Existing Condition	No-Action Alternative Change
	(Number of days)	(Number of days (%))	(Number of days)	(Number of days (%))
October	17	0 (0%)	7	0 (0%)
November	16	0 (0%)	7	0 (0%)
December	14	1.2 (8.5%)	7	0 (0%)
January	13	3.5 (27.6%)	7	0 (0%)
February	5	2.6 (55.4%)	2	0 (0%)
March	3	1.4 (45.2%)	1	0 (0%)
April	1	0 (0%)	0	0 (0%)
May	0	0 (0%)	0	0 (0%)
June	0	0 (0%)	0	0 (0%)
July	3	0 (0%)	3	0 (0%)
August	10	0 (0%)	10	0 (0%)
September	18	2.2 (12.4%)	11	0 (0%)

*Source: Version 8.0.6, DSM2 Existing and Future simulations EC at Rock Slough (Node CHCCC006) converted to chlorides at Contra Costa Canal Pumping Plant No. 1 using the equation EC*0.268-24.*
Note:
Simulation period: 1922-2003. Change as measured from Existing Condition. Dry and critical years as defined by the Sacramento Valley Index.
Percentage values reported in parenthesis are reported as zero if the change is less than one day.
Key:
% = percent
EC = electrical conductivity

Impact WQ-19e (No-Action): Delta Water Quality on the Delta-Mendota Canal at Jones Pumping Plant The water quality requirement on the Delta-Mendota Canal at Jones Pumping Plant has two components, a chloride requirement and an EC requirement. Both requirements would continue to be met under the No-Action Alternative. This impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Table 7-16 shows both the chloride and EC thresholds that must be met at Jones Pumping Plant. Tables 7-17 and 7-18 show that the No-Action Alternative would not exceed chloride thresholds. Chloride concentrations decrease in the Delta-Mendota Canal at Jones Pumping Plant under the No-Action Alternative. Tables 7-19 and 7-20 show that EC would decrease under the No-Action Alternative and would not exceed the EC threshold. The No-Action Alternative would not change the baseline compliance levels under both existing and future conditions. This impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Table 7-16. RD-1641 Water Quality Objective for the Delta-Mendota Canal at the Jones Pumping Plant

Year Type	Month	Chloride Concentration (mg/L)	Electrical conductivity (mmhos/cm)
All	October-September	250	1.0

Source: State Water Board 2000

Note:
Year types defined by Sacramento Valley Index.

Key:
mg/L = milligrams per liter
mmhos/cm = millimhos per centimeter
RD-1641 = Revised Water Right Decision 1641

Table 7-17. Simulated Monthly Average Chlorides and Percent Change for the Delta-Mendota Canal at the Jones Pumping Plant Under the Existing Condition and No-Action Alternative

Month	Average All Years		Dry and Critical Years	
	Existing Condition (mg/L)	No-Action Alternative Change (mg/L (%))	Existing Condition (mg/L)	No-Action Alternative Change (mg/L (%))
October	107.1	-1.9 (-1.8%)	117.9	-1.0 (-0.8%)
November	105.8	-2.7 (-2.6%)	118.9	-0.5 (-0.5%)
December	124.1	-6.0 (-4.8%)	142.3	-5.5 (-3.9%)
January	141.4	-11.9 (-8.4%)	165.9	-14.8 (-8.9%)
February	123.6	-9.9 (-8.0%)	159.4	-11.2 (-7.0%)
March	106.9	-9.8 (-9.2%)	157.9	-11.0 (-7.0%)
April	84.0	-15.4 (-18.4%)	123.4	-15.0 (-12.2%)
May	75.3	-9.3 (-12.3%)	106.4	-8.7 (-8.2%)
June	66.4	-5.6 (-8.4%)	81.4	-5.8 (-7.1%)
July	60.8	-2.0 (-3.3%)	83.1	-0.9 (-1.1%)
August	82.2	-1.5 (-1.9%)	121.9	-0.7 (-0.6%)
September	109.5	-2.0 (-1.8%)	145.0	-3.3 (-2.2%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node CHCDMC006)
Note:
Simulation period: 1922–2003. Change as measured from Existing Condition. Dry and critical years as defined by the Sacramento Valley Index.
Key:
% = percent
mg/L = milligrams per liter

Table 7-18. Simulated Number of Days by Month of Exceedence of the Chloride Standard for the Delta-Mendota Canal at the Jones Pumping Plant Under the Existing Condition and No-Action Alternative

Month	Total All Years		Dry and Critical Years	
	Existing Condition	No-Action Alternative Change	Existing Condition	No-Action Alternative Change
	(Number of days)	(Number of days (%))	(Number of days)	(Number of days (%))
October	0	0 (0%)	0	0 (0%)
November	0	0 (0%)	0	0 (0%)
December	0	0 (0%)	0	0 (0%)
January	0	0 (0%)	0	0 (0%)
February	0	0 (0%)	0	0 (0%)
March	0	0 (0%)	0	0 (0%)
April	0	0 (0%)	0	0 (0%)
May	0	0 (0%)	0	0 (0%)
June	0	0 (0%)	0	0 (0%)
July	0	0 (0%)	0	0 (0%)
August	0	0 (0%)	0	0 (0%)
September	0	0 (0%)	0	0 (0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node CHCDMC006)
Note:
Simulation period: 1922–2003. Change as measured from Existing Condition. Dry and critical years as defined by the Sacramento Valley Index.
Percentage values reported in parenthesis are reported as zero if the change is less than one day.
Key:
% = percent

Table 7-19. Simulated Monthly Average Salinity and Percent Change for the Delta-Mendota Canal at the Jones Pumping Plant Under the Existing Condition and No-Action Alternative

Month	Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	No-Action Alternative Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	No-Action Alternative Change (mmhos/cm (%))
October	0.6	0.0 (-1.3%)	0.6	0.0 (-0.6%)
November	0.5	0.0 (-1.8%)	0.6	0.0 (-0.3%)
December	0.6	0.0 (-3.6%)	0.7	0.0 (-3.0%)
January	0.7	0.0 (-6.4%)	0.8	-0.1 (-7.0%)
February	0.6	0.0 (-5.9%)	0.7	0.0 (-5.5%)
March	0.6	0.0 (-6.5%)	0.7	0.0 (-5.4%)
April	0.5	-0.1 (-12.1%)	0.6	-0.1 (-9.0%)
May	0.4	0.0 (-7.8%)	0.6	0.0 (-5.8%)
June	0.4	0.0 (-5.1%)	0.5	0.0 (-4.6%)
July	0.4	0.0 (-1.9%)	0.5	0.0 (-0.7%)
August	0.5	0.0 (-1.2%)	0.6	0.0 (-0.4%)
September	0.6	0.0 (-1.3%)	0.7	0.0 (-1.7%)

*Source: Version 8.0.6, DSM2 Existing and Future simulations (Node CHCDMC006) converted to chlorides using the equation EC*0.273-43.9)*

Note:

Simulation period: 1922-2003. Change as measured from Existing Condition. Dry and critical years as defined by the Sacramento Valley Index.

Key:

% = percent

mmhos/cm = millimhos per centimeter

Table 7-20. Simulated Number of Months of Exceedence of the Salinity Standard for the Delta-Mendota Canal at the Jones Pumping Plant Under the Existing Condition and No-Action Alternative

Month	Total All Years		Dry and Critical Years	
	Existing Condition	No-Action Alternative Change	Existing Condition	No-Action Alternative Change
	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))
October	0	0.0 (0.0%)	0	0.0 (0.0%)
November	0	0.0 (0.0%)	0	0.0 (0.0%)
December	0	0.0 (0.0%)	0	0.0 (0.0%)
January	0	0.0 (0.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)
April	0	0.0 (0.0%)	0	0.0 (0.0%)
May	0	0.0 (0.0%)	0	0.0 (0.0%)
June	0	0.0 (0.0%)	0	0.0 (0.0%)
July	0	0.0 (0.0%)	0	0.0 (0.0%)
August	0	0.0 (0.0%)	0	0.0 (0.0%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node CHCDMC006)

Note:
Simulation period: 1922–2003. Change as measured from Existing Condition. Dry and critical years as defined by the Sacramento Valley Index.
Percentage values reported in parenthesis are reported as zero if the change is less than one day.
Key:
% = percent

Impact WQ-19f (No-Action): Delta Water Quality on the West Canal at the Mouth of the Clifton Court Forebay The 250 mg/L chloride concentration standard at the West Canal would not be exceeded on an average annual or dry and critical year basis under the No-Action Alternative. The No-Action Alternative would result in both increases and decreases in EC in comparison to baseline conditions; however, changes in EC would not affect compliance with the standard as the Delta is operated to meet water quality standards and would continue being operated to meet standards under the No-Action Alternative. This impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Clifton Court Forebay is the source of water supply for the Banks Pumping Plant and SWP exports south of the Delta. Similar to the Delta-Mendota Canal at Jones Pumping Plant, the water quality requirement on the West Canal at the mouth of the Clifton Court Forebay has two components, a chloride requirement and an EC requirement. Table 7-21 shows both the chloride and EC concentration requirements.

Table 7-21. RD-1641 Water Quality Objective for the West Canal at the Mouth of the Clifton Court Forebay

Year Type	Month	Chloride Concentration (mg/L)	Electrical conductivity (mmhos/cm)
All	October–September	250	1.0

Source: State Water Board 2000

Note:
Year types defined by Sacramento Valley Index.

Key:
RD-1641 = Revised Water Right Decision 1641
mg/L = milligrams per liter
mmhos/cm = millimhos per centimeter

Table 7-22 shows that maximum chloride concentrations would be lower under the No-Action Alternative than the 250 mg/L threshold. Maximum increases under the No-Action Alternative would be less than 1.1 percent. As shown in Table 7-23, the maximum increase in EC values under the No-Action Alternative would be less than 1 percent, and would decrease in most months.

Table 7-22. Simulated Monthly Average Chlorides and Percent Change for West Canal at the Clifton Court Forebay Under the Existing Condition and No-Action Alternative

Month	Average All Years		Dry and Critical Years	
	Existing Condition (mg/L)	No-Action Alternative Change (mg/L (%))	Existing Condition (mg/L)	No-Action Alternative Change (mg/L (%))
October	110.8	-0.4 (-0.4%)	124.3	0.8 (0.6%)
November	107.2	-1.6 (-1.4%)	123.4	1.4 (1.1%)
December	109.2	-2.2 (-2.0%)	131.8	-0.7 (-0.6%)
January	128.1	-7.6 (-5.9%)	154.3	-9.0 (-5.8%)
February	107.5	-8.3 (-7.7%)	134.7	-10.5 (-7.8%)
March	91.9	-8.3 (-9.0%)	132.1	-9.7 (-7.3%)
April	75.6	-14.8 (-19.6%)	110.3	-14.0 (-12.7%)
May	70.8	-9.1 (-12.9%)	99.9	-8.3 (-8.3%)
June	56.4	-4.6 (-8.2%)	73.4	-4.8 (-6.6%)
July	52.2	-0.8 (-1.6%)	82.6	-0.3 (-0.4%)
August	80.5	-0.1 (-0.1%)	128.2	-0.7 (-0.6%)
September	115.0	-0.1 (-0.1%)	157.5	-2.8 (-1.8%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node CHSWP003)

Note:
Simulation period: 1922–2003. Change as measured from Existing Condition. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
mg/L = milligrams per liter

Table 7-23. Simulated Monthly Average Salinity and Percent Change for West Canal at the Clifton Court Forebay Under the Existing Condition and No-Action Alternative

Month	Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	No-Action Alternative Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	No-Action Alternative Change (mmhos/cm (%))
October	0.6	0.0 (-0.3%)	0.6	0.0 (0.5%)
November	0.6	0.0 (-1.0%)	0.6	0.0 (0.8%)
December	0.6	0.0 (-1.4%)	0.6	0.0 (-0.4%)
January	0.6	0.0 (-4.4%)	0.7	0.0 (-4.5%)
February	0.6	0.0 (-5.5%)	0.7	0.0 (-5.9%)
March	0.5	0.0 (-6.1%)	0.6	0.0 (-5.5%)
April	0.4	-0.1 (-12.4%)	0.6	-0.1 (-9.1%)
May	0.4	0.0 (-8.0%)	0.5	0.0 (-5.8%)
June	0.4	0.0 (-4.6%)	0.4	0.0 (-4.1%)
July	0.4	0.0 (-0.9%)	0.5	0.0 (-0.3%)
August	0.5	0.0 (0.0%)	0.6	0.0 (-0.4%)
September	0.6	0.0 (-0.1%)	0.7	0.0 (-1.4%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node CHSWP003)

Note:
Simulation period: 1922–2003. Change as measured from Existing Condition. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
mmhos/cm = millimhos per centimeter

Table 7-24 shows the average number of days simulated chloride values exceeded the standards of 250 mg/L for the West Canal at the Clifton Court Forebay in a year. There would be no additional violations throughout the year for average annual or dry and critical years under the No-Action Alternative. The No-Action Alternative would not change the baseline compliance levels.

Table 7-24. Simulated Number of Days by Month of Exceedence of the Chloride Standard for the West Canal at the Clifton Court Forebay Under the Existing Condition and No-Action Alternative

Month	Total All Years		Dry and Critical Years	
	Existing Condition	No-Action Alternative Change	Existing Condition	No-Action Alternative Change
	(Number of days)	(Number of days (%))	(Number of days)	(Number of days (%))
October	0	0 (0%)	0	0 (0%)
November	0	0 (0%)	0	0 (0%)
December	0	0 (0%)	0	0 (0%)
January	0	0 (0%)	0	0 (0%)
February	0	0 (0%)	0	0 (0%)
March	0	0 (0%)	0	0 (0%)
April	0	0 (0%)	0	0 (0%)
May	0	0 (0%)	0	0 (0%)
June	0	0 (0%)	0	0 (0%)
July	0	0 (0%)	0	0 (0%)
August	0	0 (0%)	0	0 (0%)
September	0	0 (0%)	0	0 (0%)
Total	0	0 (0%)	0	0 (0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node CHSWP003)

Note:
Simulation period: 1922-2003. Change as measured from Existing Condition. Dry and critical years as defined by the Sacramento Valley Index.
Percentage values reported in parenthesis are reported as zero if the change is less than one day.
Key:
% = percent

As shown in Table 7-25, the No-Action Alternative would result in potential additional violations of the salinity standards in November and December, and would result in decreases in EC violations during January. As described under Impact WQ-19c (No-Action) for Table 7-12, the apparent violations shown in Table 7-25 are referred to as "potential violations" because they occur in the model but would not occur in actual operations. The Delta is operated to meet water quality standards and would continue being operated to meet standards under the No-Action Alternative. Overall, the No-Action Alternative would not alter the compliance level for the West Canal at the Clifton Court Forebay. This impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Table 7-25. Simulated Number of Months of Exceedence of the Salinity Standard for the West Canal at the Clifton Court Forebay Under the Existing Condition and No-Action Alternative

Month	Total All Years		Dry and Critical Years	
	Existing Condition	No-Action Alternative Change	Existing Condition	No-Action Alternative Change
	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))
October	0	1.0 (0.0%)	0	0.0 (0.0%)
November	0	3.0 (0.0%)	0	2.0 (0.0%)
December	0	2.0 (0.0%)	0	1.0 (0.0%)
January	1	-1.0 (-100.0%)	1	-1.0 (-100.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)
April	0	0.0 (0.0%)	0	0.0 (0.0%)
May	0	0.0 (0.0%)	0	0.0 (0.0%)
June	0	0.0 (0.0%)	0	0.0 (0.0%)
July	0	0.0 (0.0%)	0	0.0 (0.0%)
August	0	0.0 (0.0%)	0	0.0 (0.0%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node CHSWP003)

Note:
Simulation period: 1922-2003. Change as measured from Existing Condition. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent

Impact WQ-19g (No-Action): Delta Salinity on the San Joaquin River at Vernalis Under the No-Action Alternative, on an average monthly basis, EC would meet requirements in all months, in both average years and in dry and critical years. The No-Action Alternative would exceed EC thresholds on the San Joaquin River at Vernalis in some months; however, changes in EC would not affect compliance with the standard as the Delta is operated to meet water quality standards and would continue being operated to meet standards under the No-Action Alternative. This impact would be less than significant. Mitigation is not required for the No-Action Alternative.

To protect water quality in the south Delta, RD-1641 includes a salinity objective at several locations on the San Joaquin River and on the Old River. The objective is the same for all four locations: the San Joaquin River at Airport Way Bridge in Vernalis, the San Joaquin River at Brandt Bridge, the Old River near the Middle River, and the Old River at Tracy Road Bridge. The water quality requirement is a maximum 30-day average of mean daily EC. Table 7-26 shows the south Delta water quality requirement.

Table 7-26. RD-1641 South Delta Water Quality Objective

Year Type	Months	EC Standard (mmhos/cm)
All	April–August	0.7
All	September–March	1.0

Source: State Water Board 2000

Note:
Year types defined by Sacramento Valley Index. Although requirement in RD-1641 is the maximum 30-day running average of mean daily EC, modeling uses a monthly average. San Joaquin River at Vernalis measured at the Airport Way Bridge.

Key:
RD-1641 = Revised Water Right Decision 1641
EC = electrical conductivity
mmhos/cm = millimhos per centimeter

Under the No-Action Alternative, on an average monthly basis, EC would meet requirements in most months in both average years and in dry and critical years. As shown in Tables 7-27 and 7-28, the No-Action Alternative would exceed EC thresholds on the San Joaquin River at Vernalis more frequently in July and August; however, EC would decrease under the No-Action Alternative in May and June. As described under Impact WQ-19c (No-Action) for Table 7-12, the apparent violations shown in Table 7-25 are referred to as “potential violations” because they occur in the model but would not occur in actual operations. The Delta is operated to meet water quality standards and would continue being operated to meet standards under the No-Action Alternative. Overall, the No-Action Alternative would not change the baseline compliance levels. This impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Table 7-27. Simulated Monthly Average Salinity and Percent Change for the San Joaquin River at Vernalis Under the Existing Condition and No-Action Alternative

Month	Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	No-Action Alternative Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	No-Action Alternative Change (mmhos/cm (%))
October	0.5	0.0 (-6.2%)	0.5	0.0 (-6.4%)
November	0.6	0.0 (-6.6%)	0.6	0.0 (-6.8%)
December	0.8	-0.1 (-8.5%)	0.8	-0.1 (-9.2%)
January	0.8	-0.1 (-12.2%)	0.9	-0.1 (-14.1%)
February	0.7	0.0 (-6.8%)	0.9	0.0 (-5.1%)
March	0.6	0.0 (-7.8%)	0.9	-0.1 (-6.6%)
April	0.4	-0.1 (-13.1%)	0.6	-0.1 (-9.6%)
May	0.4	0.0 (-8.4%)	0.5	0.0 (-6.7%)
June	0.5	0.0 (-5.5%)	0.6	0.0 (-4.1%)
July	0.6	0.0 (-4.0%)	0.7	0.0 (-1.1%)
August	0.6	0.0 (-6.4%)	0.6	0.0 (-3.2%)
September	0.6	0.0 (-6.6%)	0.6	0.0 (-5.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAN112)

Note:
Simulation period: 1922–2003. Change as measured from Existing Condition. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
mmhos/cm = millimhos per centimeter

Table 7-28. Simulated Number of Months of Exceedence of the Salinity Standard for the San Joaquin River at Vernalis Under the Existing Condition and No-Action Alternative

Month	Total All Years		Dry and Critical Years	
	Existing Condition	No-Action Alternative Change	Existing Condition	No-Action Alternative Change
	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))
October	0	0.0 (0.0%)	0	0.0 (0.0%)
November	0	0.0 (0.0%)	0	0.0 (0.0%)
December	0	0.0 (0.0%)	0	0.0 (0.0%)
January	0	0.0 (0.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)
April	0	0.0 (0.0%)	0	0.0 (0.0%)
May	1	-1.0 (-100.0%)	1	-1.0 (-100.0%)
June	1	-1.0 (-100.0%)	1	-1.0 (-100.0%)
July	1	0.0 (0.0%)	1	0.0 (0.0%)
August	3	-2.0 (-66.7%)	3	-2.0 (-66.7%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAN112)

Note:
Simulation period: 1922-2003. Change as measured from Existing Condition. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent

Impact WQ-19h (No-Action): Delta Salinity on the San Joaquin River at Brandt Bridge On an average monthly basis, EC would meet requirements in all months in both average years and in dry and critical years under the No-Action Alternative. The No-Action Alternative would not change EC on the San Joaquin River at Brandt Bridge. This impact would be less than significant. Mitigation is not required for the No-Action Alternative.

As previously mentioned, RD-1641 contains a south Delta water quality requirement applicable at several locations, including on the San Joaquin River at Brandt Bridge. Table 7-26 details water quality requirement standards for salinity.

On an average monthly basis, EC would meet requirements in all months in both average years and in dry and critical years, as shown in Table 7-29. Table 7-30 shows the number of months simulated EC values exceeded the standards for the San Joaquin River at Brandt Bridge in the period of simulation. The No-Action Alternative would decrease occurrence of EC values exceeding the standards in April, May, June, and August. This impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Table 7-29. Simulated Monthly Average Salinity and Percent Change for the San Joaquin River at Brandt Bridge Under the Existing Condition and No-Action Alternative

Month	Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	No-Action Alternative Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	No-Action Alternative Change (mmhos/cm (%))
October	0.5	0.0 (-6.2%)	0.5	0.0 (-6.3%)
November	0.6	0.0 (-6.5%)	0.6	0.0 (-6.8%)
December	0.8	-0.1 (-8.2%)	0.8	-0.1 (-8.9%)
January	0.8	-0.1 (-11.7%)	0.9	-0.1 (-13.6%)
February	0.7	0.0 (-7.0%)	0.9	-0.1 (-5.7%)
March	0.6	0.0 (-7.6%)	0.9	-0.1 (-6.3%)
April	0.4	-0.1 (-12.7%)	0.6	-0.1 (-9.2%)
May	0.4	0.0 (-8.2%)	0.6	0.0 (-6.3%)
June	0.5	0.0 (-5.3%)	0.6	0.0 (-3.9%)
July	0.6	0.0 (-4.0%)	0.7	0.0 (-1.3%)
August	0.6	0.0 (-5.8%)	0.6	0.0 (-2.7%)
September	0.6	0.0 (-6.4%)	0.6	0.0 (-4.8%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAN072)
Note:
Simulation period: 1922–2003. Change as measured from Existing Condition. Dry and critical years as defined by the Sacramento Valley Index.
Key:
% = percent
mmhos/cm = millimhos per centimeter

Table 7-30. Simulated Number of Months of Exceedence of the Salinity Standard for the San Joaquin River at Brandt Bridge Under the Existing Condition and No-Action Alternative

Month	Total All Years		Dry and Critical Years	
	Existing Condition	No-Action Alternative Change	Existing Condition	No-Action Alternative Change
	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))
October	0	0.0 (0.0%)	0	0.0 (0.0%)
November	0	0.0 (0.0%)	0	0.0 (0.0%)
December	0	0.0 (0.0%)	0	0.0 (0.0%)
January	0	0.0 (0.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)
April	2	-1.0 (-50.0%)	2	-1.0 (-50.0%)
May	1	-1.0 (-100.0%)	1	-1.0 (-100.0%)
June	1	-1.0 (-100.0%)	1	-1.0 (-100.0%)
July	1	0.0 (0.0%)	1	0.0 (0.0%)
August	2	-1.0 (-50.0%)	2	-1.0 (-50.0%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAN072)

Note:
Simulation period: 1922-2003. Change as measured from Existing Condition. Dry and critical years as defined by the Sacramento Valley Index.
Key:
% = percent

Impact WQ-19i (No-Action): Delta Salinity on the Old River near the Middle River Under the No-Action Alternative, on an average monthly basis, EC would meet requirements in all months in both average years and in dry and critical years. The No-Action Alternative would decrease EC on the Old River near the Middle River. This impact would be less than significant. Mitigation is not required for the No-Action Alternative.

As previously mentioned, RD-1641 contains a south Delta water quality requirement applicable at several locations, including on the Old River near the Middle River. Table 7-26 details water quality requirement standards for salinity.

On an average monthly basis, EC would meet requirements in all months in both average years and in dry and critical years, as shown in Table 7-31. Table 7-32 shows the number of months simulated EC values exceeded the standards for the Old River near the Middle River in the period of simulation. The No-Action Alternative would decrease occurrence of EC values exceeding the standards in April, May, June, and August. This impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Table 7-31. Simulated Monthly Average Salinity and Percent Change for the Old River near the Middle River Under the Existing Condition and No-Action Alternative

Month	Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	No-Action Alternative Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	No-Action Alternative Change (mmhos/cm (%))
October	0.4	0.0 (-2.0%)	0.5	0.0 (-1.8%)
November	0.5	0.0 (-2.9%)	0.5	0.0 (-2.2%)
December	0.5	0.0 (-1.4%)	0.5	0.0 (-0.6%)
January	0.6	0.0 (-2.3%)	0.6	0.0 (-2.3%)
February	0.6	0.0 (-4.7%)	0.6	0.0 (-5.6%)
March	0.5	0.0 (-6.0%)	0.6	0.0 (-5.8%)
April	0.5	0.0 (-9.7%)	0.6	0.0 (-6.3%)
May	0.4	0.0 (-8.3%)	0.5	0.0 (-5.9%)
June	0.4	0.0 (-5.1%)	0.4	0.0 (-4.6%)
July	0.3	0.0 (-1.6%)	0.4	0.0 (-0.8%)
August	0.4	0.0 (-0.8%)	0.5	0.0 (-0.2%)
September	0.4	0.0 (-1.3%)	0.5	0.0 (-1.5%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RMID040)

Note:
Simulation period: 1922–2003. Change as measured from Existing Condition. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
mmhos/cm = millimhos per centimeter

Table 7-32. Simulated Number of Months of Exceedence of the Salinity Standard for the Old River near the Middle River Under the Existing Condition and No-Action Alternative

Month	Total All Years		Dry and Critical Years	
	Existing Condition	No-Action Alternative Change	Existing Condition	No-Action Alternative Change
	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))
October	0	0.0 (0.0%)	0	0.0 (0.0%)
November	0	0.0 (0.0%)	0	0.0 (0.0%)
December	0	0.0 (0.0%)	0	0.0 (0.0%)
January	0	0.0 (0.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)
April	2	-1.0 (-50.0%)	2	-1.0 (-50.0%)
May	1	-1.0 (-100.0%)	1	-1.0 (-100.0%)
June	1	-1.0 (-100.0%)	1	-1.0 (-100.0%)
July	1	0.0 (0.0%)	1	0.0 (0.0%)
August	2	-1.0 (-50.0%)	2	-1.0 (-50.0%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RMID040)

Note:
Simulation period: 1922-2003. Change as measured from Existing Condition. Dry and critical years as defined by the Sacramento Valley Index.
Key:
% = percent

Impact WQ-19j (No-Action): Delta Salinity on the Old River at Tracy Road Bridge Under the No-Action Alternative on an average monthly basis, EC would meet requirements in all months in both average years and in dry and critical years, and would decrease EC on the Old River at Tracy Road Bridge in some months. This impact would be less than significant. Mitigation is not required for the No-Action Alternative.

As previously mentioned, RD-1641 contains a south Delta water quality requirement applicable at several locations, including on the Old River at Tracy Road Bridge. Table 7-26 details water quality requirement standards for salinity.

The No-Action Alternative would decrease EC on the Old River at Tracy Road Bridge in some months, as shown in Table 7-33. Table 7-34 shows the number of months simulated EC values exceeded the standards for the Old River near Tracy Road Bridge in the period of simulation. The No-Action Alternative would decrease occurrence of EC values exceeding the standards in April, May, and August. This impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Table 7-33. Simulated Monthly Average Salinity and Percent Change for the Old River at Tracy Road Bridge Under the Existing Condition and No-Action Alternative

Month	Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	No-Action Alternative Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	No-Action Alternative Change (mmhos/cm (%))
October	0.5	0.0 (-5.5%)	0.6	0.0 (-5.7%)
November	0.6	0.0 (-6.1%)	0.6	0.0 (-6.5%)
December	0.8	-0.1 (-7.9%)	0.8	-0.1 (-8.7%)
January	0.8	-0.1 (-10.3%)	0.9	-0.1 (-12.4%)
February	0.7	0.0 (-6.5%)	0.9	-0.1 (-5.6%)
March	0.6	0.0 (-7.1%)	0.9	-0.1 (-5.9%)
April	0.5	-0.1 (-12.2%)	0.6	-0.1 (-8.8%)
May	0.4	0.0 (-8.0%)	0.6	0.0 (-6.1%)
June	0.5	0.0 (-5.0%)	0.6	0.0 (-3.6%)
July	0.6	0.0 (-3.9%)	0.7	0.0 (-1.8%)
August	0.6	0.0 (-4.6%)	0.6	0.0 (-1.1%)
September	0.6	0.0 (-5.1%)	0.6	0.0 (-2.4%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node ROLD059)
Note:
Simulation period: 1922–2003. Change as measured from Existing Condition. Dry and critical years as defined by the Sacramento Valley Index.
Key:
% = percent
mmhos/cm = millimhos per centimeter

Table 7-34. Simulated Number of Months of Exceedence of the Salinity Standard for the Old River at Tracy Road Bridge Under the Existing Condition and No-Action Alternative

Month	Total All Years		Dry and Critical Years	
	Existing Condition	No-Action Alternative Change	Existing Condition	No-Action Alternative Change
	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))
October	0	0.0 (0.0%)	0	0.0 (0.0%)
November	0	0.0 (0.0%)	0	0.0 (0.0%)
December	0	0.0 (0.0%)	0	0.0 (0.0%)
January	1	-1.0 (-100.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)
April	7	-2.0 (-28.6%)	7	-2.0 (-28.6%)
May	1	-1.0 (-100.0%)	1	-1.0 (-100.0%)
June	0	0.0 (0.0%)	0	0.0 (0.0%)
July	0	0.0 (0.0%)	0	0.0 (0.0%)
August	4	-1.0 (-25.0%)	4	-1.0 (-25.0%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node ROLD059)

Note:
Simulation period: 1922-2003. Change as measured from Existing Condition. Dry and critical years as defined by the Sacramento Valley Index.
Percentage values reported in parenthesis are reported as zero if the change is less than one day.
Key:
% = percent

Impact WQ-20 (No-Action): X2 Position The No-Action Alternative would change average monthly X2 in some months by more than 0.1 kilometer (km). This impact would be potentially significant.

Table 7-35 shows the simulated monthly average X2 position for the No-Action Alternative compared to the existing condition. As previously described, the X2 parameter is measured in distance upstream from the Golden Gate Bridge in Suisun Bay, and is required to be maintained at not more than 75 km during the months of February through June. CalSim-II calculates the X2 position on a 1-month delay; the values shown have been corrected to accurately reflect the X2 position for the specified month. As shown in Table 7-35, the No-Action Alternative would shift X2 upstream by up to 0.2 km in May and June on an average annual basis, and by as much as 0.4 km in May of dry and critical years. This impact would be potentially significant. Mitigation is not required for the No-Action Alternative.

Table 7-35. Simulated Monthly Average X2 Position Under the Existing Condition and No-Action Alternative

Month	Average All Years		Dry and Critical Years	
	Existing Condition (km)	No-Action Alternative Change (km (%))	Existing Condition (km)	No-Action Alternative Change (km (%))
October	83.9	0.0 (0.0%)	86.6	0.0 (0.0%)
November	82.2	0.0 (0.0%)	86.5	0.1 (0.1%)
December	76.1	-0.1 (-0.1%)	84.8	-0.1 (-0.2%)
January	67.5	-0.2 (-0.3%)	79.6	-0.3 (-0.4%)
February	60.9	-0.1 (-0.2%)	72.5	-0.2 (-0.3%)
March	60.9	0.0 (0.0%)	70.3	0.0 (0.0%)
April	63.5	-0.1 (-0.2%)	72.9	0.0 (0.0%)
May	67.5	0.2 (0.2%)	77.6	0.4 (0.5%)
June	74.5	0.2 (0.2%)	82.6	0.2 (0.3%)
July	80.5	0.0 (0.1%)	86.1	0.0 (0.0%)
August	85.6	0.0 (0.0%)	88.8	-0.2 (-0.3%)
September	82.6	0.0 (0.0%)	91.1	-0.2 (-0.2%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node X2_PRV)

Note:

Simulation period: 1922-2003. Change as measured from Existing Condition. Dry and critical years as defined by the Sacramento Valley Index.

Key:

% = percent

km = kilometer

X2 = geographic location of 2 parts per thousand near-bottom salinity isohaline in the Delta, measured in distance upstream from Golden Gate Bridge in Suisun Bay.

CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

CP1 focuses on increasing water supply reliability and increasing anadromous fish survival. This plan primarily consists of raising Shasta Dam by 6.5 feet, which, in combination with spillway modifications, would increase the height of the reservoir's full pool by 8.5 feet and enlarge the total storage capacity in the reservoir by 256,000 acre-feet. The existing TCD would also be extended to achieve efficient use of the expanded CWP. Shasta Dam operational guidelines would continue essentially unchanged, except during dry years and critical years, when 70,000 acre-feet and 35,000 acre-feet, respectively, of the increased storage capacity in Shasta Reservoir would be reserved to specifically focus on increasing M&I deliveries. CP1 would help reduce future water shortages through increasing drought year and average year water supply reliability for agricultural and M&I deliveries. In addition, the increased depth and volume of the CWP in Shasta Reservoir would contribute to improving seasonal water temperatures for anadromous fish in the upper Sacramento River.

Shasta Lake and Vicinity

Impact WQ-1 (CP1): Temporary Construction-Related Sediment Effects on Shasta Lake and Its Tributaries that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses The construction-related activities described in Chapter 2, "Alternatives," would result in short-term changes in the amount of exposed area that would be subject to erosion. In addition to the clearing of vegetation in various areas to accommodate relocation activities, about 500 acres of vegetation in various arms of Shasta Lake would be cleared before inundation. Removal of vegetation would reduce the amount of effective ground cover (e.g., duff, large woody debris), thereby increasing the potential for short-term erosion and sedimentation along the shoreline. This impact would be potentially significant.

The relocation activities would result in exposing about 698 acres to some amount of soil disturbance. These effects are described in more detail in Chapter 4, "Geology, Geomorphology, Minerals, and Soils." The disturbed sites would have the potential to contribute sediments to nearby water bodies.

Although the environmental commitments, including BMPs described in Chapter 2, "Alternatives," are intended to reduce the potential effects of introducing sediment into Shasta Lake and its tributaries, CP1 would affect water quality by increasing the levels of turbidity and suspended sediment in the receiving waters at levels that could be inconsistent with the Basin Plan. These increased levels of turbidity and suspended sediment could affect the beneficial uses of Shasta Lake and/or its tributaries. Therefore, the impact would be potentially significant. Mitigation for this impact is proposed in Section 7.3.5.

Impact WQ-2 (CP1): Temporary Construction-Related Temperature Effects on Shasta Lake and Its Tributaries that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses Because of the large water surface area of Shasta Lake, coupled with the isolated and discrete nature of the relocation activities on the tributaries, temporary construction-related effects are not expected to modify water temperature in a manner that would have a negative effect on beneficial uses or result in a water quality violation. Therefore, this impact would be less than significant.

Under CP1, construction activities associated with enlarging Shasta Dam as well as the relocation actions would result in sizeable areas that would be subject to surface disturbance, including jurisdictional waters within the influence zone associated with CP1. Efforts to document jurisdictional waters associated with relocation areas are described in Chapter 12 "Botanical Resources and Wetlands." This information has been updated since the DEIS was circulated for public review. If the SLWRI is authorized, Reclamation will work closely with its cooperating agencies to ensure compliance with the CWA (e.g., Section 401 and 404) consistent with the development of the least environmentally damaging preferred alternative (LEDPA).

Environmental commitments and BMPs for the various construction and relocation activities (e.g., bridge replacement, boat ramp construction, demolition of facilities) have been incorporated into CP1. These activities could include removal of riparian vegetation, thereby exposing water bodies to increased solar radiation for various time periods. As described in Chapter 2, “Alternatives,” and the “Preliminary Environmental Commitments and Mitigation Plan Appendix,” riparian revegetation would be implemented at all construction and relocation sites as applicable to ensure that shade is quickly reestablished after construction is completed.

As described in Chapter 2, “Alternatives,” although the TCD may not be operational for some period of time during construction, project sequencing would ensure that changes to water temperature in Shasta Lake and downstream in the upper Sacramento River, as well as associated limnological conditions in Shasta Lake, would be consistent with those that occur periodically under the No-Action Alternative typically associated with maintenance and outage periods.

Because of the large water surface area of Shasta Lake, coupled with the isolated and discrete nature of the relocation activities on the tributaries, temporary construction-related effects are not expected to modify water temperature in a manner that would have a negative effect on beneficial uses or result in a water quality violation. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-3 (CP1): Temporary Construction-Related Metal Effects on Shasta Lake and Its Tributaries that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses Under CP1, no construction activities would occur that would disturb locations known to contain elevated metal concentrations in either sediments or the water column. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-4 (CP1): Long-Term Sediment Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in Shasta Lake or Its Tributaries Under CP1, the exposure of an additional 1,227 acres of shoreline surrounding Shasta Lake would result in a potential for increased wave-related shoreline erosion (see Chapter 4, “Geology, Geomorphology, Minerals, and Soils”). As the reservoir is lowered during summer and fall, the exposed surface area would also be subject to surficial erosion processes that could mobilize and transport sediment to the newly expanded Shasta Lake. Although environmental commitments and BMPs are incorporated into the project description, the project would result in an incremental increase in the delivery of suspended sediment and turbidity to the receiving waters. The amount of sediment that could be delivered is not entirely quantifiable because of the size of the lake and the number of variables that influence sediment transport and delivery. Chapter 4, “Geology, Geomorphology, Minerals, and

Soils," does provide information on the estimated volume of sediment that may be introduced into Shasta Lake as a result of increases in shoreline erosion. Under CP1, it's estimated that about 421,000 cubic yards per year would be delivered to Shasta Lake as a result of shoreline erosion. This impact would be potentially significant. Mitigation for this impact is proposed in Section 7.3.5.

Impact WQ-5 (CP1): Long-Term Temperature Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in Shasta Lake or Its Tributaries CP1 would store some additional flows behind Shasta Dam during periods when the flows would have otherwise been released downstream. The resulting increase in storage would then be used both to create an expanded CWP available for carryover storage, thus benefiting fisheries, and for subsequent release to support beneficial uses downstream. On average, CP1 would provide approximately a 5 percent increase in annual storage.

Table 7-36 shows the simulated monthly change in storage for CP1 as a percent increase above the existing condition.

Table 7-36. Simulated Average Increased End-of-Month Shasta Lake Storage – CP1

Month	Existing Conditions (TAF)	CP1 Change (TAF)	CP1 % Increase
October	2,592	148	5.7%
November	2,568	142	5.5%
December	2,722	161	5.9%
January	2,995	167	5.6%
February	3,267	178	5.5%
March	3,625	182	5.0%
April	3,916	177	4.5%
May	3,941	179	4.5%
June	3,639	178	4.9%
July	3,160	170	5.4%
August	2,834	166	5.9%
September	2,669	157	5.9%

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node S4+S44)
Note:
Simulation period: 1922-2003. Change as measured from Existing Condition.
Key:
% = percent
CP = Comprehensive Plan
TAF = thousand acre-feet

Under CP1, existing water temperature requirements would typically be met in most years; therefore, the additional increase in water storage shown in Table 7-36 would primarily be released for water supply purposes. Accordingly, minimal increases in releases from Shasta Dam would be expected in months when Delta exports are constrained, or when flow is not usable for water supply purposes.

As shown in Table 7-36, the increase in storage provided by CP1 fluctuates greatly throughout a year; storage is typically highest at the end of winter, in April and May, as the need for flood control reservation space in the reservoir is reduced. Storage is typically at its lowest in September, October, and November, after summer irrigation concludes and before winter refill begins. Additional runoff captured by the increased storage increment would typically remain in storage and available to support beneficial uses downstream. Conversely, if insufficient water in storage existed to meet downstream demands, the first increment to be reduced would be deliveries to water service contractors. As such, increased releases would typically be made on a schedule providing increased reliability of deliveries to water service contractors, typically in July through October of relatively dry years.

A key indicator of the water temperature benefits of CP1 to the upper Sacramento River between Keswick Dam and Red Bluff is the amount of cold water available in Shasta Lake before the water temperature operation season, about May through October. As previously described, Shasta Lake generally reaches its maximum storage during late April or early May. Also, the CWP volume in the lake accumulates during winter and early spring and is not likely to increase after April. Therefore, the expected increase in spring storage for CP1 should also result in an incremental increase in the CWP volume.

The simulated end-of-April volume of water with a temperature lower than 52°F for the existing condition and the change in CWP volume for CP1 is shown, by Sacramento Valley Index (SVI) year type, in Table 7-37.

In addition to illustrating the average change in available CWP, Table 7-37 also shows the influence of climatic conditions on these values. The diversity between water year types, coupled with unique combinations of storage and rainfall, would continue to influence the ability to manage storage in Shasta Lake to maximize carryover capacity. Although an increase in the active storage and carryover storage of the CWP would occur, the impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-37. Simulated Average Volume of Water Less than 52°F in Shasta Lake at the End of April – CP1

SVI Year Type	Existing Conditions (TAF)	CP1 Change (TAF)	% Increase
Average of All Years	2,609	142	5%
Wet	2,916	194	7%
Above Normal	2,972	163	5%
Below Normal	2,699	129	5%
Dry	2,542	130	5%
Critical	1,601	49	3%

Source: BST (Benchmark Study Team) April 2010 version SRWQM 2005 and 2030 simulations.
Notes:
Simulation period: 1922–2003. Change as measured from Existing Condition.
Year types as defined by the Sacramento Valley Index
Key:
°F = degrees Farenheit
% = percent
CP = Comprehensive Plan
SVI = Sacramento Valley Index
TAF = thousand acre-feet

Impact WQ-6 (CP1): Long-Term Metals Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in Shasta Lake or Its Tributaries The increase in storage associated with CP1 would result in modifying the depth and thickness of the thermocline in Shasta Lake. The level of change would be correlated to a number of parameters, including carryover storage, climatic conditions, and the timing and duration of stratification (Bartholow et al. 2001). A study conducted by the CVRWQCB in 2002 and 2003 suggests that a direct correlation exists between dissolved copper concentrations in the upper levels of Shasta Lake near the dam and dissolved copper concentrations in the waters immediately downstream from the power plant (CVRWQCB 2003a). This study concluded that there appears to be a correlation between operation of the TCD and concentration of dissolved metals within the thermocline; an increase in available storage, however, would increase the opportunity to dilute metals concentrations below current levels.

Within the Squaw Creek Arm, two depositional features associated with historic copper mining and smelting operations are immediately adjacent to the shoreline of Shasta Lake in the general vicinity of the Bully Hill Mine. As mapped, these two sites appear to have about 7,300 cubic yards of material that could be subjected to shoreline and surficial erosional processes, with a high potential for delivery to Shasta Lake. This impact would be potentially significant. Mitigation for this impact is proposed in Section 7.3.5.

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact WQ-7 (CP1): Temporary Construction-Related Sediment Effects on the Upper Sacramento River that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses Construction would include ground-disturbing activities that could result in soil erosion and sediment effects on the upper Sacramento River. This impact would be potentially significant.

As described in Impact WQ-1 (CP1), ground-disturbing activities associated with construction could cause soil erosion and sedimentation of local drainages and eventually the Sacramento River. Construction activities could also discharge waste petroleum products or other construction-related substances that could enter these waterways/facilities in runoff. The environmental protection measures and BMPs described in Chapter 2, "Alternatives," are intended to reduce the potential effects of introducing sediment into Shasta Lake and into downstream releases to the upper Sacramento River; however, CP1 would affect water quality by increasing the levels of turbidity and suspended sediment in the receiving waters at levels that could be inconsistent with the Basin Plan. These increased levels of turbidity and suspended sediment could affect the beneficial uses of the upper Sacramento River. Therefore, this impact would be potentially significant. Mitigation for this impact is proposed in Section 7.3.5.

Impact WQ-8 (CP1): Temporary Construction-Related Temperature Effects on the Upper Sacramento River that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses Construction activities are not anticipated to result in temperature effects on the upper Sacramento River because changes to water temperature in Shasta Lake and subsequent releases to the Sacramento River would be consistent with typical periodic fluctuations. This impact would be less than significant.

As described for Impact WQ-2 (CP1), changes to water temperature and associated limnological conditions in Shasta Lake would be consistent with those that occur periodically under the No-Action Alternative associated with maintenance and outage periods. Therefore, water temperatures in the upper Sacramento River, which are related to releases from Shasta Lake, would not be expected to be modified during construction in a manner that would negatively affect beneficial uses or result in a water quality violation. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-9 (CP1): Temporary Construction-Related Metal Effects on the Upper Sacramento River that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses Construction activities are not anticipated to result in water quality effects on the upper Sacramento River related to metals because construction would not disturb locations of known elevated metal concentrations. This impact would be less than significant.

As described in Impact WQ-3 (CP1), there would be no construction activities that would disturb locations known to contain elevated metal concentrations in either sediments or the water column of Shasta Lake. Because water quality in the upper Sacramento River is related to the quality of releases from Shasta Lake, metals concentrations would not be expected to be modified during construction in a manner that would negatively affect beneficial uses or result in a water quality violation. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-10 (CP1): Long-Term Sediment Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Upper Sacramento River No long-term water quality impacts are anticipated in the upper Sacramento River in regard to sediment, because modeling results have indicated that CP1 would cause little change in average mean monthly flow, and could cause a decrease in peak flows that are associated with increased sediment transport. This impact would be less than significant.

Long-term effects on water quality could be caused by changes in the size and timing of releases from the reservoir associated with CP1. The analysis used flow data from hydrologic modeling as an indicator of effects on sediment and metals.

For CP1, fall and winter flows on the upper Sacramento River would be reduced in some years, and summer flows would increase in many years. In addition, retention of winter flows would reduce or eliminate some overbank flood events in the upper Sacramento River. Because the reservoir would be able to store additional water during high-flow periods, in some years wintertime peak flows would be reduced as a result of the project. High-flow events transport sediments and can produce bank erosion and meander.

The Basin Plan specifies that changes to suspended sediment loading and discharge rates cannot cause nuisance or adversely affect beneficial uses (CVRWQCB 2007b). Under both existing and future conditions, analysis of modeling results indicates that the generally small changes in average mean monthly flow from CP1 are unlikely to have a significant effect on sediment transport within the upper Sacramento River. In addition, it appears that CP1 would reduce wintertime peak flow events, which may reduce sediment loading and discharge rates. Beneficial uses that may be beneficially affected include municipal and domestic supply, irrigation and stock watering, service supply, power, contact recreation and canoeing and rafting, other noncontact recreation, and navigation. However, there could be varying effects on beneficial uses concerning habitat, such as freshwater and spawning habitat. These impacts are explored further in Chapter 11, “Fisheries and Aquatic Resources.” Because the project would cause little change in average mean monthly flow, and a potential decrease in peak flows, the impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-11 (CP1): Long-Term Temperature Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Upper Sacramento River Analysis of temperature modeling results indicates that CP1 would improve compliance with the temperature requirements on the Sacramento River because of the increased depth of the CWP in Shasta Lake and the associated enhanced ability to regulate water temperature releases to the upper Sacramento River. Therefore, the impact of CP1 on water quality measured as temperature would be beneficial.

CP1 would increase the ability of Shasta Dam to release cold water and regulate water temperature in the upper Sacramento River, primarily in dry and critical years. This would be accomplished by raising Shasta Dam 6.5 feet, thus increasing the depth of the CWP in Shasta Lake and resulting in an increase in seasonal cold-water volume below the thermocline (i.e., layer of greatest water temperature and density change). Cold water released from Shasta Dam influences water temperature conditions in the Sacramento River between Keswick Dam and RBPP, with effects diminishing downstream.

This section focuses on compliance with water quality standards for temperature. For an analysis of temperature effects on fisheries and aquatic habitat, see Chapter 11, "Fisheries and Aquatic Resources."

Analysis of temperature modeling results indicates that CP1 would improve compliance with the temperature requirements on the Sacramento River. The 2009 BO for CVP and SWP operations and their effects on the Sacramento River winter-run Chinook salmon require that Sacramento River water temperatures be below 56°F at compliance locations between Balls Ferry and Bend Bridge from April 15 through September 30, and not in excess of 60°F at the same compliance locations in during October. Currently, this standard is not always met, particularly in dry and critical years. CP1 would reduce the amount of daily exceedences of the 2009 BO standards under both existing and future conditions. Table 7-38 provides a summary of modeled reductions in exceedences over the 82-year modeling period under each of the alternatives.

Based on this analysis, the impact of CP1 on water quality measured as temperature would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Table 7-38. Modeled Reduction in Daily Exceedences of Sacramento River Temperature Requirements (as Defined by the 2009 Biological Opinion for CVP and SWP Operations and Their Effects on the Sacramento River Winter-Run Chinook Salmon) for April 15 – October 31

Comprehensive Plan	Existing Conditions (2005)		Future Conditions (2030)	
	Balls Ferry	Bend Bridge	Balls Ferry	Bend Bridge
CP1	7%	5%	11%	4%
CP2	13%	7%	14%	7%
CP3	17%	10%	19%	11%
CP4	29%	13%	32%	13%
CP4A	25%	11%	25%	11%
CP5	15%	10%	16%	11%

Source: BST (Benchmark Study Team) April 2010 version SRWQM 2005 and 2030 simulations

Note:
Simulation period: 1922–2003
Source: Data provided by MWH

Key:
% = percent
CP = Comprehensive Plan
CVP = Central Valley Project
SWP = State Water Project

Impact WQ-12 (CP1): Long-Term Metals Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Upper Sacramento River Long-term operation of the project could result in water quality effects on the upper Sacramento River in regard to metals as a result of erosional processes to historic mining and smelting operation features. This impact would be potentially significant.

The analysis used flow data from hydrologic modeling as an indicator of effects on sediment and metals. The Sacramento River and its tributaries upstream from Keswick Dam are the primary source of metals to the lower Sacramento River (USGS 2000b). Shasta Lake is also listed as impaired for metals. As described in Impact WQ-6 (CP1), a study conducted by the CVRWQCB in 2002 and 2003 suggests that a direct correlation exists between dissolved copper concentrations in the upper levels of Shasta Lake near the dam and dissolved copper concentrations in the waters immediately downstream from the power plant (CVRWQCB 2003a).

The 25-mile reach of the Sacramento River from Keswick Dam downstream to Cottonwood Creek is impaired for cadmium, copper, and zinc. The CVRWQCB developed a TMDL program for these constituents in the upper Sacramento River because of exceedences of water quality standards. Heavy metals such as copper, zinc, mercury, lead, and cadmium are water quality parameters that are impairing beneficial uses. Natural mineral deposits and historical mining practices are a source of metals, including mercury, within Shasta Lake and the upper Sacramento River. High metals concentrations in the Sacramento River correlate with concentrations of suspended sediment and high flows because metals are transported adsorbed to suspended sediments (USGS 2000b; Domagalski et al. 2000).

Under both existing and future conditions, the generally small changes in average mean monthly flow from the project predicted by modeling are unlikely to have a significant effect on metals within the upper Sacramento River and would not be expected to result in exceedences of the dissolved metals numeric targets established in the TMDL (as shown in Table 7-3). Remediation activities at Iron Mountain Mine and other mine sites over the last several years, as well as dredging of contaminated sediment in the Spring Creek Arm of Keswick Reservoir in 2009 and 2010, are also expected to reduce the likelihood of future exceedences of the TMDL numeric targets below Keswick Dam.

However, as described in Impact WQ-6 (CP1), two depositional features associated with historic copper mining and smelting operation within the Squaw Creek Arm of Shasta Lake could be subjected to shoreline and surficial erosional processes, with a high potential for delivery to Shasta Lake and subsequent delivery to the upper Sacramento River. Therefore, the water quality impact of CP1 related to metals in the upper Sacramento River would be potentially significant. Mitigation for this impact is proposed in Section 7.3.5.

Lower Sacramento River and Delta and CVP/SWP Service Areas

Impact WQ-13 (CP1): Temporary Construction-Related Sediment Effects on the Extended Study Area that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses Construction is not anticipated to affect water quality conditions in the extended study area. This impact would be less than significant.

Construction would only temporarily influence water quality in the primary study area. Construction effects are anticipated to be localized and would be further minimized with appropriate BMPs. Therefore, construction is not anticipated to affect water quality conditions downstream in the extended study area. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-14 (CP1): Temporary Construction-Related Temperature Effects on the Extended Study Area that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses As described in Impact WQ-13 (CP1), construction is not anticipated to affect water temperature in the extended study area. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-15 (CP1): Temporary Construction-Related Metal Effects on the Extended Study Area that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses As described in Impact WQ-13 (CP1), construction is not anticipated to affect metals in the extended study area. This

impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-16 (CP1): Long-Term Sediment Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Extended Study Area Water quality effects of CP1 could influence the extended study area, but effects would diminish with distance into the study area. Water quality effects are attenuated by multiple factors including flow from tributaries, stormwater runoff, and municipal and agricultural discharges, as described below.

Because the Sacramento River is the primary supplier of suspended sediment to the Delta, sediment loading and discharge rates from the upper Sacramento River could affect water quality and beneficial uses in the extended study area. However, changes in sediment loading in the upper Sacramento River would be less than significant and changes in the extended study area would be even smaller. Therefore, the impact on sediment would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-17 (CP1): Long-Term Temperature Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Extended Study Area Analysis of temperature modeling shows little to no change in temperature at RBPP caused by CP1. This suggests that there would be no changes in temperature beyond RBPP as a result of CP1. This conclusion is further supported by the operational experience of the CVP, which indicates that the 60-mile stretch of river between Keswick Dam and Red Bluff is the extent to which the Shasta-Trinity Division can control temperatures through normal operations of the CVP. Therefore, no temperature effects are anticipated in the extended study area. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-18 (CP1): Long-Term Metals Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Extended Study Area CP1 would alter the operations of Shasta Lake. Increases in metals concentrations can result from changes in flows that cause increases in concentrations of suspended sediments during high-flow periods. The reduction in frequency and magnitude of peak flow events resulting from CP1 would suggest a beneficial impact for metals; however, as described in Impact WQ-6 (CP1), two depositional features associated with historic copper mining and smelting operation within the Squaw Creek Arm of Shasta Lake could be subjected to shoreline and surficial erosional processes, with the potential for delivery to Shasta Lake and subsequent delivery to the Sacramento River. Therefore, the effects of CP1 related to metals in the lower Sacramento River could be potentially significant because operation of the project could add substantial additional amounts of metal to the river system. Thus, the impact would be potentially significant. Mitigation for this impact is proposed in Section 7.3.5.

Salinity CP1 would differ from the No-Action Alternative primarily through a 256,000 acre-feet enlargement of Shasta Lake. Potential impacts, which are evaluated below, include changes in the following:

- Delta salinity on the Sacramento River at Collinsville
- Delta salinity on the San Joaquin River at Jersey Point
- Delta salinity on the Sacramento River at Emmaton
- Delta salinity on the Old River at Rock Slough
- Delta water quality on the Delta-Mendota Canal at Jones Pumping Plant
- Delta water quality on the West Canal at the mouth of the Clifton Court Forebay
- Delta salinity on the San Joaquin River at Vernalis
- Delta salinity on the San Joaquin River at Brandt Bridge
- Delta salinity on the Old River near the Middle River
- Delta salinity on the Old River at Tracy Road Bridge
- X2 position

Impact WQ-19a (CP1): Delta Salinity on the Sacramento River at Collinsville Operations for CP1 would result in both increases and decreases in salinity in comparison with baseline conditions; however, none of the increases would be sufficient to change compliance for the Sacramento River at Collinsville. On a percentage basis, all increases in salinity would be less than 5 percent. This impact would be less than significant.

The water quality requirement on the Sacramento River at Collinsville is specified in RD-1641, and is defined for all year types, from October through April. The RD-1641 objectives for the Sacramento River at Collinsville are defined in Table 7-4.

As shown in Table 7-39, operations for CP1 would result in both increases and decreases in salinity; however, none of the increases would be sufficient to change compliance for the Sacramento River at Collinsville. On a percentage basis, all increases in salinity would be less than 5 percent. Table 7-40 shows the number of months simulated EC values exceeded the standards for the Sacramento River at Collinsville in the period of simulation. The operation of CP1 would not result in any violations of the salinity standards for the Sacramento River at Collinsville under both existing and future conditions. This

impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-39. Simulated Monthly Average Salinity and Percent Change for the Sacramento River at Collinsville Under Baseline Conditions and CP1

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	CP1 Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	CP1 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP1 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP1 Change (mmhos/cm (%))
October	6.0	0.0 (-0.5%)	7.1	0.0 (-0.1%)	6.0	0.0 (-0.6%)	7.1	0.0 (-0.4%)
November	5.1	0.0 (0.4%)	6.8	0.0 (-0.1%)	5.1	0.0 (0.2%)	6.9	0.0 (-0.4%)
December	3.6	0.0 (0.4%)	5.5	0.0 (0.6%)	3.6	0.0 (-0.1%)	5.5	0.0 (-0.2%)
January	1.8	0.0 (-0.3%)	3.4	0.0 (0.0%)	1.7	0.0 (0.8%)	3.3	0.0 (1.5%)
February	0.8	0.0 (0.6%)	1.7	0.0 (1.2%)	0.8	0.0 (1.2%)	1.6	0.0 (1.8%)
March	0.6	0.0 (0.4%)	1.2	0.0 (0.4%)	0.6	0.0 (0.6%)	1.1	0.0 (0.8%)
April	0.7	0.0 (0.0%)	1.4	0.0 (0.0%)	0.7	0.0 (-0.3%)	1.5	0.0 (-0.5%)
May	1.1	0.0 (0.1%)	2.3	0.0 (0.1%)	1.1	0.0 (-0.6%)	2.4	0.0 (-0.7%)
June	2.2	0.0 (0.2%)	4.0	0.0 (0.2%)	2.2	0.0 (0.1%)	4.1	0.0 (-0.2%)
July	3.2	0.0 (0.1%)	5.3	0.0 (0.0%)	3.2	0.0 (0.1%)	5.5	0.0 (0.0%)
August	5.3	0.0 (-0.2%)	7.3	0.0 (-0.4%)	5.4	0.0 (-0.2%)	7.4	0.0 (-0.4%)
September	5.2	0.0 (-0.5%)	8.8	-0.1 (-0.7%)	5.2	0.0 (-0.6%)	8.8	-0.1 (-1.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAC081)

Note:
Simulation period: 1922–2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
mmhos/cm = millimhos per centimeter

Table 7-40. Simulated Number of Months of Exceedence of the Salinity Standard for the Sacramento River at Collinsville Under Baseline Conditions and CP1

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition	CP1 Change	Existing Condition	CP1 Change	No-Action Alternative	CP1 Change	No-Action Alternative	CP1 Change
	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))
October	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
November	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
December	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
January	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
April	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
May	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
June	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
July	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
August	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAC081)

Note:
Simulation period: 1922–2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan

Impact WQ-19b (CP1): Delta Salinity on the San Joaquin River at Jersey Point
Operations for CP1 would result in both increases and decreases in salinity in comparison with baseline conditions; however, none of the increases would be sufficient to change compliance for the San Joaquin River at Jersey Point. On a percentage basis, all increases in salinity would be less than 5 percent. This impact would be less than significant.

The water quality requirement on the San Joaquin River at Jersey Point is specified in RD-1641 as two components. The first component of the requirement begins on April 1, and extends through a year-type-dependent date. The second component of the Jersey Point requirement begins at the end of the first component, and ends on August 15. The numerical requirement of the second component is dependent on the year type. Objectives for the San Joaquin River at Jersey Point are defined in Table 7-7.

Table 7-41 shows simulated monthly average salinity and percent change for the San Joaquin River at Jersey Point. On an average monthly basis EC requirements would be satisfied in all months in an average year under CP1 operations. Furthermore, all changes during April through August would be less than 2 percent. Table 7-42 shows the number of months simulated EC values exceeded the standards for the San Joaquin River at Jersey Point in the period of simulation. CP1 would result in an increase in the frequency of violations under existing conditions. Violations occur during June and are 10 percent for all years and 12.5 percent during dry and critical years. The long-term and dry- and critical-year average EC values in June are found to be below the standards, which indicate the violation is marginal and does not show any significant changes in water quality in June. Overall, the frequency of exceedence of salinity standards for the San Joaquin River at Jersey Point under CP1 would be similar to those under existing and future conditions.

This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-41. Simulated Monthly Average Salinity and Percent Change for the San Joaquin River at Jersey Point Under Baseline Conditions and CP1

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	CP1 Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	CP1 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP1 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP1 Change (mmhos/cm (%))
October	1.6	0.0 (-0.1%)	1.8	0.0 (0.1%)	1.6	0.0 (0.0%)	1.9	0.0 (-0.2%)
November	1.5	0.0 (1.7%)	1.8	0.0 (0.9%)	1.5	0.0 (1.3%)	1.8	0.0 (0.9%)
December	1.2	0.0 (1.2%)	1.8	0.0 (1.1%)	1.2	0.0 (0.5%)	1.7	0.0 (0.1%)
January	0.7	0.0 (0.8%)	1.1	0.0 (1.8%)	0.7	0.0 (1.3%)	1.0	0.0 (2.6%)
February	0.3	0.0 (1.2%)	0.5	0.0 (2.4%)	0.3	0.0 (2.3%)	0.5	0.0 (4.5%)
March	0.3	0.0 (0.2%)	0.3	0.0 (0.7%)	0.3	0.0 (0.8%)	0.3	0.0 (1.7%)
April	0.3	0.0 (0.0%)	0.3	0.0 (0.2%)	0.3	0.0 (0.1%)	0.3	0.0 (0.3%)
May	0.3	0.0 (0.1%)	0.4	0.0 (0.2%)	0.3	0.0 (0.0%)	0.4	0.0 (-0.1%)
June	0.4	0.0 (0.1%)	0.7	0.0 (0.2%)	0.4	0.0 (0.1%)	0.7	0.0 (-0.1%)
July	1.0	0.0 (0.3%)	1.7	0.0 (0.5%)	1.0	0.0 (0.6%)	1.7	0.0 (0.9%)
August	1.6	0.0 (0.0%)	2.2	0.0 (0.0%)	1.6	0.0 (0.1%)	2.1	0.0 (0.5%)
September	1.9	0.0 (0.4%)	2.8	0.0 (0.6%)	1.9	0.0 (0.5%)	2.8	0.0 (0.9%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAN018)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
mmhos/cm = millimhos per centimeter

Table 7-42. Simulated Number of Months of Exceedence of the Salinity Standard for the San Joaquin River at Jersey Point Under Baseline Conditions and CP1

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition	CP1 Change	Existing Condition	CP1 Change	No-Action Alternative	CP1 Change	No-Action Alternative	CP1 Change
	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))
October	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
November	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
December	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
January	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
April	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
May	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
June	10	1.0 (10.0%)	8	1.0 (12.5%)	13	0.0 (0.0%)	11	0.0 (0.0%)
July	51	0.0 (0.0%)	22	0.0 (0.0%)	50	1.0 (2.0%)	21	1.0 (4.8%)
August	73	0.0 (0.0%)	25	0.0 (0.0%)	76	0.0 (0.0%)	27	0.0 (0.0%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAN018)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan

Impact WQ-19c (CP1): Delta Salinity on the Sacramento River at Emmaton
Operations for CP1 would result in both increases and decreases in salinity in comparison to baseline conditions; however, none of the increases would be sufficient to change compliance for the Sacramento River at Emmaton. On a percentage basis, all increases in salinity would be less than 5 percent. This impact would be less than significant.

Similar to the water quality requirement on the San Joaquin River at Jersey Point, the water quality requirement on the Sacramento River at Emmaton is specified in RD-1641 as two components. The first component of the requirement begins on April 1, and extends through a year-type-dependent date. The second component of the Emmaton requirement begins at the end of the first component, and ends on August 15. The numerical requirement of the second component is dependent on the year type. Objectives for the Sacramento River at Emmaton are defined in Table 7-10.

Although Table 7-43 shows the EC for all months, the Emmaton water quality requirement is only defined for April 1 through August 15. On an average monthly basis, no change in the ability to meet EC requirements would occur in all months in an average year under CP1 operations. Maximum change in monthly EC would not be greater than 2.1 percent under both existing and future conditions. Table 7-44 shows the number of months simulated EC values exceeded the standards for the Sacramento River at Emmaton in the period of simulation. Operations of CP1 would not result in any additional violation of salinity standards between October and March. CP1 would result in an increase in the frequency of violations under existing and future conditions during May, by up to 100 percent in all years and dry and critical years. However, CP1 would result in a decrease in the frequency of violations under existing and future conditions during August and April, by up to 11.5 percent in all years and up to 50 percent during dry and critical years. Overall, the compliance of standards for the Sacramento River at Emmaton would be similar to the baseline levels under both existing and future conditions. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-43. Simulated Monthly Average Salinity and Percent Change for the Sacramento River at Emmaton Under Baseline Conditions and CP1

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	CP1 Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	CP1 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP1 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP1 Change (mmhos/cm (%))
October	2.0	0.0 (-0.9%)	2.4	0.0 (-0.3%)	2.0	0.0 (-1.2%)	2.5	0.0 (-0.8%)
November	1.5	0.0 (-0.1%)	2.2	0.0 (-0.5%)	1.5	0.0 (-0.4%)	2.3	0.0 (-1.0%)
December	1.0	0.0 (0.2%)	1.5	0.0 (0.3%)	0.9	0.0 (-0.5%)	1.5	0.0 (-1.1%)
January	0.5	0.0 (-0.2%)	0.7	0.0 (0.0%)	0.4	0.0 (0.9%)	0.7	0.0 (1.8%)
February	0.3	0.0 (1.0%)	0.4	0.0 (2.1%)	0.3	0.0 (0.9%)	0.4	0.0 (1.7%)
March	0.2	0.0 (0.3%)	0.3	0.0 (0.5%)	0.2	0.0 (0.6%)	0.3	0.0 (1.3%)
April	0.3	0.0 (0.0%)	0.3	0.0 (0.1%)	0.3	0.0 (-0.1%)	0.4	0.0 (-0.2%)
May	0.3	0.0 (0.1%)	0.5	0.0 (0.2%)	0.3	0.0 (-0.4%)	0.6	0.0 (-0.7%)
June	0.6	0.0 (0.2%)	1.1	0.0 (0.3%)	0.6	0.0 (0.0%)	1.1	0.0 (-0.1%)
July	0.7	0.0 (-0.1%)	1.3	0.0 (-0.1%)	0.8	0.0 (-0.2%)	1.4	0.0 (-0.4%)
August	1.4	0.0 (-0.4%)	2.3	0.0 (-0.8%)	1.5	0.0 (-0.4%)	2.3	0.0 (-0.8%)
September	1.6	0.0 (-1.4%)	3.0	-0.1 (-2.0%)	1.6	0.0 (-1.6%)	3.1	-0.1 (-2.3%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAC092)

Note:
Simulation period: 1922–2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
mmhos/cm = millimhos per centimeter

Table 7-44. Simulated Number of Months of Exceedence of the Salinity Standard for the San Sacramento River at Emmaton Under Baseline Conditions and CP1

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition	CP1 Change	Existing Condition	CP1 Change	No-Action Alternative	CP1 Change	No-Action Alternative	CP1 Change
	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))
October	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
November	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
December	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
January	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
April	1	0.0 (0.0%)	1	0.0 (0.0%)	2	-1.0 (-50.0%)	2	-1.0 (-50.0%)
May	1	1.0 (100.0%)	1	1.0 (100.0%)	3	1.0 (33.3%)	3	1.0 (33.3%)
June	28	0.0 (0.0%)	18	0.0 (0.0%)	27	0.0 (0.0%)	19	0.0 (0.0%)
July	1	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)
August	69	-3.0 (-4.3%)	26	-3.0 (-11.5%)	70	-3.0 (-4.3%)	26	-3.0 (-11.5%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAC092)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan

Impact WQ-19d (CP1): Delta Salinity on the Old River at Rock Slough On an average annual basis, all months except September through January under both the existing condition and future condition would be less than 150 mg/L. Change in chloride concentration would not affect compliance with the standard as it would already be exceeded under the basis of comparison. This impact would be less than significant.

Rock Slough is the location of the CCWD diversion for the Contra Costa Canal, but compliance with the salinity objectives is measured at Contra Costa Canal Pumping Plant No. 1. However, simulating water quality at Contra Costa Canal Pumping Plant No. 1 is difficult, and DSM2 does not explicitly simulate water quality at that location. Instead, a transfer function is applied to estimate the water quality at Contra Costa Canal Pumping Plant No. 1 based on the simulated water quality at Old River at Rock Slough from DSM2. The requirements, as defined in RD-1641, specify a minimum number of days during the calendar year that the maximum mean daily chloride concentration of 150 mg/L must be maintained. Objectives for the Contra Costa Canal Pumping Plant No. 1 are defined in Table 7-13.

Table 7-45 shows simulated monthly average chloride concentrations and percent change for Contra Costa Canal Pumping Plant No. 1. On an average annual basis, CP1 would not increase chloride concentrations by more than 1.1 percent. Maximum changes in chloride concentrations under the CP1 are less than 2.1 percent for dry and critical years.

Table 7-46 shows the average number of days in a year simulated chloride values exceeded the standard of 150 mg/L for Contra Costa Canal Pumping Plant No. 1. No additional daily violations of the chloride standards are shown to occur under both existing and future conditions for CP1, as compared with baseline conditions. Overall, CP1 would not alter the compliance level for Contra Costa Canal Pumping Plant No. 1 observed under both existing and future conditions.

This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-45. Simulated Monthly Average Chlorides and Percent Change for Contra Costa Canal Pumping Plant No. 1 Under Baseline Conditions and CP1

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mg/L)	CP1 Change (mg/L (%))	Existing Condition (mg/L)	CP1 Change (mg/L (%))	No-Action Alternative (mg/L)	CP1 Change (mg/L (%))	No-Action Alternative (mg/L)	CP1 Change (mg/L (%))
October	156.2	-0.1 (-0.1%)	175.6	-0.9 (-0.5%)	157.1	0.0 (0.0%)	176.7	-0.9 (-0.5%)
November	154.9	-0.5 (-0.3%)	177.7	-0.1 (-0.1%)	155.3	0.3 (0.2%)	181.1	-0.3 (-0.2%)
December	144.3	1.6 (1.1%)	178.3	1.1 (0.6%)	151.7	0.4 (0.2%)	186.7	0.9 (0.5%)
January	153.9	1.2 (0.8%)	183.5	3.1 (1.7%)	164.9	0.7 (0.4%)	197.1	1.6 (0.8%)
February	106.2	0.8 (0.7%)	112.3	2.4 (2.1%)	119.2	0.8 (0.6%)	115.5	1.9 (1.6%)
March	95.2	0.1 (0.1%)	92.3	1.1 (1.2%)	103.8	0.5 (0.5%)	95.6	1.2 (1.3%)
April	88.4	-0.4 (-0.4%)	86.6	0.2 (0.3%)	90.0	0.3 (0.3%)	85.4	0.6 (0.7%)
May	90.4	-0.2 (-0.2%)	92.3	0.1 (0.1%)	87.5	0.1 (0.1%)	87.2	0.1 (0.1%)
June	62.4	0.0 (0.1%)	75.8	0.1 (0.1%)	61.5	0.0 (0.0%)	75.4	0.0 (0.0%)
July	73.8	0.3 (0.3%)	111.3	0.7 (0.6%)	76.6	0.3 (0.4%)	115.5	0.6 (0.5%)
August	117.0	0.4 (0.4%)	182.4	1.0 (0.5%)	122.0	0.3 (0.3%)	186.3	1.2 (0.7%)
September	158.5	0.2 (0.2%)	210.3	0.4 (0.2%)	167.1	0.0 (0.0%)	208.4	0.4 (0.2%)

*Source: Version 8.0.6, DSM2 Existing and Future simulations EC at Old River at Rock Slough (Node CHCCC006), converted to chlorides at Contra Costa Canal Pumping Plant No. 1 using the equation EC*0.268-24.*

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
EC = electrical conductivity
mg/L = milligrams per liter

Table 7-46. Simulated Number of Days by Month of Exceedence of the Chloride Standard for Contra Costa Canal Pumping Plant No. 1 Under Baseline Conditions and CP1

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition	CP1 Change	Existing Condition	CP1 Change	No-Action Alternative	CP1 Change	No-Action Alternative	CP1 Change
	(Number of days)	(Number of days (%))	(Number of days)	(Number of days (%))	(Number of days)	(Number of days (%))	(Number of days)	(Number of days (%))
October	17	0 (0%)	7	0 (0%)	17	0 (0%)	7	0 (0%)
November	16	0 (0%)	7	0 (0%)	16	0 (0%)	7	0 (0%)
December	14	0 (0%)	7	0 (0%)	15	0 (0%)	7	0 (0%)
January	13	0 (0%)	7	0 (0%)	16	0 (0%)	8	0 (0%)
February	5	0 (0%)	2	0 (0%)	7	0 (0%)	2	0 (0%)
March	3	0 (0%)	1	0 (0%)	5	0 (0%)	0	0 (0%)
April	1	0 (0%)	0	0 (0%)	1	0 (0%)	0	0 (0%)
May	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
June	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
July	3	0 (0%)	3	0 (0%)	3	0 (0%)	3	0 (0%)
August	10	0 (0%)	10	0 (0%)	11	0 (0%)	10	0 (0%)
September	18	0 (0%)	11	0 (0%)	20	0 (0%)	11	0 (0%)
Total	99	0 (0%)	54	0 (0%)	111	0 (0%)	56	0 (0%)

*Source: Version 8.0.6, DSM2 Existing and Future simulations EC at Old River at Rock Slough (Node CHCCC006), converted to chlorides at Contra Costa Canal Pumping Plant No. 1 using the equation EC*0.268-24.*

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index. Percentage values reported in parenthesis are reported as zero if the change is less than one day.

Key:
% = percent
CP = Comprehensive Plan
EC = electrical conductivity

Impact WQ-19e (CP1): Delta Water Quality on the Delta-Mendota Canal at Jones Pumping Plant The water quality requirement on the Delta-Mendota Canal at Jones Pumping Plant has two components, a chloride requirement and an EC requirement. Both requirements would continue to be met under CP1 under both existing and future conditions. This impact would be less than significant.

Table 7-16 shows both the chloride and EC thresholds that must be met at Jones Pumping Plant. Tables 7-47 and 7-48 show that CP1 would not exceed chloride thresholds. All increases in chloride concentrations would be less than 5 percent under CP1. Tables 7-49 and 7-50 show that increases in EC would be less than 1.0 percent under CP1 and would not exceed the EC threshold. CP1 would not change the baseline compliance levels under both existing and future conditions. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-47. Simulated Monthly Average Chlorides and Percent Change for the Delta-Mendota Canal at the Jones Pumping Plant Under Baseline Conditions and CP1

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mg/L)	CP1 Change (mg/L (%))	Existing Condition (mg/L)	CP1 Change (mg/L (%))	No-Action Alternative (mg/L)	CP1 Change (mg/L (%))	No-Action Alternative (mg/L)	CP1 Change (mg/L (%))
October	107.1	-0.2 (-0.2%)	117.9	-0.5 (-0.4%)	105.1	-0.3 (-0.2%)	117.0	-0.9 (-0.8%)
November	105.8	0.0 (0.0%)	118.9	0.0 (0.0%)	103.1	0.1 (0.1%)	118.4	-0.3 (-0.3%)
December	124.1	1.0 (0.8%)	142.3	0.8 (0.6%)	118.1	0.5 (0.4%)	136.7	0.6 (0.5%)
January	141.4	0.2 (0.1%)	165.9	0.5 (0.3%)	129.5	0.2 (0.2%)	151.2	0.7 (0.5%)
February	123.6	0.5 (0.4%)	159.4	1.2 (0.7%)	113.7	0.0 (0.0%)	148.2	0.3 (0.2%)
March	106.9	-0.3 (-0.3%)	157.9	0.1 (0.1%)	97.1	0.4 (0.4%)	146.9	0.9 (0.6%)
April	84.0	0.0 (0.0%)	123.4	0.1 (0.1%)	68.6	0.1 (0.2%)	108.4	0.4 (0.3%)
May	75.3	0.0 (0.0%)	106.4	-0.1 (0.0%)	66.0	0.0 (0.0%)	97.7	0.0 (0.0%)
June	66.4	0.0 (0.0%)	81.4	0.1 (0.1%)	60.8	-0.1 (-0.1%)	75.6	0.1 (0.2%)
July	60.8	0.2 (0.4%)	83.1	0.7 (0.8%)	58.8	0.2 (0.3%)	82.1	0.4 (0.4%)
August	82.2	0.3 (0.4%)	121.9	0.7 (0.6%)	80.6	0.3 (0.4%)	121.2	1.0 (0.9%)
September	109.5	0.3 (0.3%)	145.0	0.7 (0.5%)	107.5	0.1 (0.1%)	141.7	0.5 (0.4%)

*Source: Version 8.0.6, DSM2 Existing and Future simulations (Node CHCDMC006) converted to chlorides using the equation EC*0.273-43.9)*

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
mg/L = milligrams per liter

Table 7-48. Simulated Number of Days by Month of Exceedence of the Chloride Standard for the Delta-Mendota Canal at the Jones Pumping Plant Under Baseline Conditions and CP1

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition	CP1 Change	Existing Condition	CP1 Change	No-Action Alternative	CP1 Change	No-Action Alternative	CP1 Change
	(Number of days)	(Number of days (%))	(Number of days)	(Number of days (%))	(Number of days)	(Number of days (%))	(Number of days)	(Number of days (%))
October	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
November	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
December	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
January	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
February	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
March	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
April	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
May	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
June	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
July	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
August	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
September	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
Total	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node CHCDMC006)

Note:
Simulation period: 1922–2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index. Percentage values reported in parenthesis are reported as zero if the change is less than one day.

Key:
% = percent
CP = Comprehensive Plan

Table 7-49. Simulated Monthly Average Salinity and Percent Change for the Delta-Mendota Canal at the Jones Pumping Plant Under Baseline Conditions and CP1

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	CP1 Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	CP1 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP1 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP1 Change (mmhos/cm (%))
October	0.6	0.0 (-0.2%)	0.6	0.0 (-0.3%)	0.5	0.0 (-0.2%)	0.6	0.0 (-0.6%)
November	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)	0.5	0.0 (0.1%)	0.6	0.0 (-0.2%)
December	0.6	0.0 (0.6%)	0.7	0.0 (0.4%)	0.6	0.0 (0.3%)	0.7	0.0 (0.3%)
January	0.7	0.0 (0.1%)	0.8	0.0 (0.3%)	0.6	0.0 (0.1%)	0.7	0.0 (0.4%)
February	0.6	0.0 (0.3%)	0.7	0.0 (0.6%)	0.6	0.0 (0.0%)	0.7	0.0 (0.2%)
March	0.6	0.0 (-0.2%)	0.7	0.0 (0.1%)	0.5	0.0 (0.3%)	0.7	0.0 (0.5%)
April	0.5	0.0 (0.0%)	0.6	0.0 (0.1%)	0.4	0.0 (0.1%)	0.6	0.0 (0.2%)
May	0.4	0.0 (0.0%)	0.6	0.0 (0.0%)	0.4	0.0 (0.0%)	0.5	0.0 (0.0%)
June	0.4	0.0 (0.0%)	0.5	0.0 (0.1%)	0.4	0.0 (-0.1%)	0.4	0.0 (0.1%)
July	0.4	0.0 (0.2%)	0.5	0.0 (0.5%)	0.4	0.0 (0.2%)	0.5	0.0 (0.3%)
August	0.5	0.0 (0.2%)	0.6	0.0 (0.4%)	0.5	0.0 (0.3%)	0.6	0.0 (0.6%)
September	0.6	0.0 (0.2%)	0.7	0.0 (0.4%)	0.6	0.0 (0.1%)	0.7	0.0 (0.3%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node CHCDMC006)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
mmhos/cm = millimhos per centimeter

Table 7-50. Simulated Number of Months of Exceedence of the Salinity Standard for the Delta-Mendota Canal at the Jones Pumping Plant Under Baseline Conditions and CP1

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition	CP1 Change	Existing Condition	CP1 Change	No-Action Alternative	CP1 Change	No-Action Alternative	CP1 Change
	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))
October	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
November	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
December	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
January	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
April	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
May	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
June	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
July	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
August	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node CHCDMC006)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan

Impact WQ-19f (CP1): Delta Water Quality on the West Canal at the Mouth of the Clifton Court Forebay The 250 mg/L chloride concentration standard at the West Canal would not be exceeded on an average annual or dry and critical year basis under CP1. CP1 would also not exceed EC thresholds. This impact would be less than significant.

Clifton Court Forebay is the source of water supply for the Banks Pumping Plant and SWP exports south of the Delta. Similar to the Delta-Mendota Canal at Jones Pumping Plant, the water quality requirement on the West Canal at the mouth of the Clifton Court Forebay has two components, a chloride requirement and an EC requirement. Table 7-21 shows both the chloride and EC concentration requirements.

Table 7-51 shows that maximum chloride concentrations under both existing and future project conditions are lower for CP1 than the 250 mg/L threshold. Maximum changes under both existing and future projection conditions are less than 1.5 percent. As shown in Table 7-52, CP1 the maximum change in EC values under existing and future project conditions would be less than 1.5 percent.

Table 7-51. Simulated Monthly Average Chlorides and Percent Change for West Canal at the Clifton Court Forebay Under Baseline Conditions and CP1

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mg/L)	CP1 Change (mg/L (%))	Existing Condition (mg/L)	CP1 Change (mg/L (%))	No-Action Alternative (mg/L)	CP1 Change (mg/L (%))	No-Action Alternative (mg/L)	CP1 Change (mg/L (%))
October	110.8	-0.3 (-0.3%)	124.3	-0.7 (-0.5%)	110.4	-0.1 (-0.1%)	125.1	-0.9 (-0.7%)
November	107.2	0.2 (0.2%)	123.4	0.1 (0.1%)	105.7	0.4 (0.4%)	124.8	0.0 (0.0%)
December	109.2	1.6 (1.4%)	131.8	1.2 (0.9%)	107.0	0.8 (0.8%)	131.1	0.9 (0.7%)
January	128.1	0.7 (0.5%)	154.3	1.6 (1.0%)	120.5	0.4 (0.3%)	145.3	1.0 (0.7%)
February	107.5	0.5 (0.5%)	134.7	1.4 (1.1%)	99.2	0.3 (0.3%)	124.2	1.0 (0.8%)
March	91.9	-0.2 (-0.2%)	132.1	0.5 (0.4%)	83.6	0.5 (0.6%)	122.4	1.4 (1.1%)
April	75.6	0.0 (0.0%)	110.3	0.2 (0.2%)	60.8	0.2 (0.4%)	96.4	0.6 (0.7%)
May	70.8	0.0 (0.0%)	99.9	0.0 (0.0%)	61.6	0.0 (0.1%)	91.6	0.1 (0.1%)
June	56.4	0.0 (0.0%)	73.4	0.1 (0.1%)	51.8	-0.1 (-0.1%)	68.6	0.1 (0.1%)
July	52.2	0.3 (0.5%)	82.6	0.8 (1.0%)	51.3	0.2 (0.3%)	82.3	0.3 (0.4%)
August	80.5	0.2 (0.3%)	128.2	0.5 (0.4%)	80.4	0.3 (0.4%)	127.5	1.1 (0.9%)
September	115.0	0.3 (0.3%)	157.5	0.7 (0.4%)	114.9	0.2 (0.2%)	154.7	0.7 (0.5%)

*Source: Version 8.0.6, DSM2 Existing and Future simulations (Node CHSWP003) converted to chlorides using the equation EC*0.273-43.9)*

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
EC = electrical conductivity
mg/L= milligrams per liter

Table 7-52. Simulated Monthly Average Salinity and Percent Change for West Canal at the Clifton Court Forebay Under Baseline Conditions and CP1

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	CP1 Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	CP1 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP1 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP1 Change (mmhos/cm (%))
October	0.6	0.0 (-0.2%)	0.6	0.0 (-0.4%)	0.6	0.0 (-0.1%)	0.6	0.0 (-0.5%)
November	0.6	0.0 (0.2%)	0.6	0.0 (0.1%)	0.5	0.0 (0.3%)	0.6	0.0 (0.0%)
December	0.6	0.0 (1.0%)	0.6	0.0 (0.7%)	0.6	0.0 (0.5%)	0.6	0.0 (0.5%)
January	0.6	0.0 (0.4%)	0.7	0.0 (0.8%)	0.6	0.0 (0.2%)	0.7	0.0 (0.5%)
February	0.6	0.0 (0.4%)	0.7	0.0 (0.8%)	0.5	0.0 (0.2%)	0.6	0.0 (0.6%)
March	0.5	0.0 (-0.2%)	0.6	0.0 (0.3%)	0.5	0.0 (0.4%)	0.6	0.0 (0.8%)
April	0.4	0.0 (0.0%)	0.6	0.0 (0.1%)	0.4	0.0 (0.2%)	0.5	0.0 (0.5%)
May	0.4	0.0 (0.0%)	0.5	0.0 (0.0%)	0.4	0.0 (0.0%)	0.5	0.0 (0.1%)
June	0.4	0.0 (0.0%)	0.4	0.0 (0.1%)	0.4	0.0 (-0.1%)	0.4	0.0 (0.1%)
July	0.4	0.0 (0.3%)	0.5	0.0 (0.6%)	0.3	0.0 (0.2%)	0.5	0.0 (0.3%)
August	0.5	0.0 (0.2%)	0.6	0.0 (0.3%)	0.5	0.0 (0.2%)	0.6	0.0 (0.6%)
September	0.6	0.0 (0.2%)	0.7	0.0 (0.4%)	0.6	0.0 (0.1%)	0.7	0.0 (0.4%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node CHSWP003)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
mmhos/cm = millimhos per centimeter

Table 7-53 shows the average number of days simulated chloride values exceeded the standards of 250 mg/L for the West Canal at the Clifton Court Forebay in a year. There would be no additional violations throughout the year for average annual or dry and critical years, under both existing and future project conditions. CP1 would not change the baseline compliance levels under both existing and future conditions.

As shown in Table 7-54, CP1 would not result in any additional violations of the salinity standards. CP1 would actually result in decreases in EC during several months of the year. CP1 would not change the baseline compliance levels under both existing and future conditions.

The impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-53. Simulated Number of Days by Month of Exceedence of the Chloride Standard for the West Canal at the Clifton Court Forebay Under Baseline Conditions and CP1

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition	CP1 Change	Existing Condition	CP1 Change	No-Action Alternative	CP1 Change	No-Action Alternative	CP1 Change
	(Number of days)	(Number of days (%))	(Number of days)	(Number of days (%))	(Number of days)	(Number of days (%))	(Number of days)	(Number of days (%))
October	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
November	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
December	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
January	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
February	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
March	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
April	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
May	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
June	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
July	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
August	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
September	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
Total	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node CHSWP003)

Note:

Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index. Percentage values reported in parenthesis are reported as zero if the change is less than one day.

Key:

% = percent

CP = Comprehensive Plan

Table 7-54. Simulated Number of Months of Exceedence of the Salinity Standard for the West Canal at the Clifton Court Forebay Under Baseline Conditions and CP1

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition	CP1 Change	Existing Condition	CP1 Change	No-Action Alternative	CP1 Change	No-Action Alternative	CP1 Change
	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months (%))	(Number of months (%))	(Number of months)	(Number of months (%))
October	0	0.0 (0.0%)	0	0.0 (0.0%)	1	0.0 (0.0%)	0	0.0 (0.0%)
November	0	1.0 (0.0%)	0	0.0 (0.0%)	3	-2.0 (-66.7%)	2	-1.0 (-50.0%)
December	0	0.0 (0.0%)	0	0.0 (0.0%)	2	-1.0 (-50.0%)	1	0.0 (0.0%)
January	1	-1.0 (-100.0%)	1	-1.0 (-100.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
April	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
May	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
June	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
July	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
August	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node CHSWP003)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan

Impact WQ-19g (CP1): Delta Salinity on the San Joaquin River at Vernalis On an average monthly basis, EC would meet requirements in all months, in both average years and in dry and critical years. Moreover, CP1 would not exceed EC thresholds on the San Joaquin River at Vernalis. This impact would be less than significant.

To protect water quality in the south Delta, RD-1641 includes a salinity objective at several locations on the San Joaquin River and on the Old River. The objective is the same for all four locations: the San Joaquin River at Airport Way Bridge in Vernalis, the San Joaquin River at Brandt Bridge, the Old River near the Middle River, and the Old River at Tracy Road Bridge. The water quality requirement is a maximum 30-day average of mean daily EC. Table 7-26 shows the south Delta water quality requirement.

On an average monthly basis, EC would meet requirements in all months in both average years and in dry and critical years. CP1 would not exceed EC thresholds on the San Joaquin River at Vernalis, as shown in Tables 7-55 and 7-56. CP1 would not change the baseline compliance levels under both existing and future conditions.

This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-55. Simulated Monthly Average Salinity and Percent Change for the San Joaquin River at Vernalis Under Baseline Conditions and CP1

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	CP1 Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	CP1 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP1 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP1 Change (mmhos/cm (%))
October	0.5	0.0 (0.0%)	0.5	0.0 (0.0%)	0.5	0.0 (0.0%)	0.5	0.0 (0.0%)
November	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)
December	0.8	0.0 (0.0%)	0.8	0.0 (0.0%)	0.7	0.0 (0.0%)	0.8	0.0 (0.0%)
January	0.8	0.0 (0.0%)	0.9	0.0 (0.0%)	0.7	0.0 (0.0%)	0.8	0.0 (0.0%)
February	0.7	0.0 (0.0%)	0.9	0.0 (0.0%)	0.7	0.0 (0.0%)	0.9	0.0 (0.0%)
March	0.6	0.0 (0.0%)	0.9	0.0 (0.0%)	0.6	0.0 (0.0%)	0.8	0.0 (0.0%)
April	0.4	0.0 (0.0%)	0.6	0.0 (0.0%)	0.4	0.0 (0.0%)	0.5	0.0 (0.0%)
May	0.4	0.0 (0.0%)	0.5	0.0 (0.0%)	0.4	0.0 (0.0%)	0.5	0.0 (0.0%)
June	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)
July	0.6	0.0 (0.0%)	0.7	0.0 (0.0%)	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)
August	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)
September	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAN112)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
mmhos/cm = millimhos per centimeter

Table 7-56. Simulated Number of Months of Exceedence of the Salinity Standard for the San Joaquin River at Vernalis Under Baseline Conditions and CP1

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition	CP1 Change	Existing Condition	CP1 Change	No-Action Alternative	CP1 Change	No-Action Alternative	CP1 Change
	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))
October	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
November	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
December	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
January	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
April	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
May	1	0.0 (0.0%)	1	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
June	1	0.0 (0.0%)	1	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
July	1	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)
August	3	0.0 (0.0%)	3	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAN112)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan

Impact WQ-19h (CP1): Delta Salinity on the San Joaquin River at Brandt Bridge On an average monthly basis, EC would meet requirements in all months in both average years and in dry and critical years. CP1 would not change EC on the San Joaquin River at Brandt Bridge. This impact would be less than significant.

As previously mentioned, RD-1641 contains a south Delta water quality requirement applicable at several locations, including on the San Joaquin River at Brandt Bridge. Table 7-26 details water quality requirement standards for salinity.

On an average monthly basis, EC would meet requirements in all months in both average years and in dry and critical years, as shown in Table 7-57. Table 7-58 shows the number of months simulated EC values exceeded the standards for the San Joaquin River at Brandt Bridge in the period of simulation. CP1 would not change the existing compliance level under both existing and future project conditions.

This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-57. Simulated Monthly Average Salinity and Percent Change for the San Joaquin River at Brandt Bridge Under Baseline Conditions and CP1

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	CP1 Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	CP1 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP1 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP1 Change (mmhos/cm (%))
October	0.5	0.0 (0.0%)	0.5	0.0 (0.0%)	0.5	0.0 (0.0%)	0.5	0.0 (0.0%)
November	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)
December	0.8	0.0 (0.0%)	0.8	0.0 (0.0%)	0.7	0.0 (0.0%)	0.8	0.0 (0.0%)
January	0.8	0.0 (0.0%)	0.9	0.0 (0.0%)	0.7	0.0 (0.0%)	0.8	0.0 (0.0%)
February	0.7	0.0 (0.0%)	0.9	0.0 (0.0%)	0.7	0.0 (0.0%)	0.9	0.0 (0.0%)
March	0.6	0.0 (0.0%)	0.9	0.0 (0.0%)	0.6	0.0 (0.0%)	0.8	0.0 (0.0%)
April	0.4	0.0 (0.0%)	0.6	0.0 (0.0%)	0.4	0.0 (0.0%)	0.5	0.0 (0.0%)
May	0.4	0.0 (0.0%)	0.6	0.0 (0.0%)	0.4	0.0 (0.0%)	0.5	0.0 (0.0%)
June	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)
July	0.6	0.0 (0.0%)	0.7	0.0 (0.1%)	0.6	0.0 (0.0%)	0.7	0.0 (0.0%)
August	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)
September	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAN072)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percentCP = Comprehensive Plan
mmhos/cm = millimhos per centimeter

Table 7-58. Simulated Number of Months of Exceedence of the Salinity Standard for the San Joaquin River at Brandt Bridge Under Baseline Conditions and CP1

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition	CP1 Change	Existing Condition	CP1 Change	No-Action Alternative	CP1 Change	No-Action Alternative	CP1 Change
	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))
October	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
November	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
December	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
January	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
April	2	0.0 (0.0%)	2	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)
May	1	0.0 (0.0%)	1	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
June	1	0.0 (0.0%)	1	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
July	1	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)
August	2	0.0 (0.0%)	2	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAN072)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan

Impact WQ-19i (CP1): Delta Salinity on the Old River near the Middle River
On an average monthly basis, EC would meet requirements in all months in both average years and in dry and critical years. CP1 would not measurably change EC on the Old River near the Middle River. This impact would be less than significant.

As previously mentioned, RD-1641 contains a south Delta water quality requirement applicable at several locations, including on the Old River near the Middle River. Table 7-26 details water quality requirement standards for salinity.

On an average monthly basis, EC would meet requirements in all months in both average years and in dry and critical years, as shown in Table 7-59. Table 7-60 shows the number of months simulated EC values exceeded the standards for the Old River near the Middle River in the period of simulation. Compliance with salinity standards for the Old River near the Middle River would not change under CP1. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-59. Simulated Monthly Average Salinity and Percent Change for the Old River near the Middle River Under Baseline Conditions and CP1

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	CP1 Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	CP1 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP1 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP1 Change (mmhos/cm (%))
October	0.5	0.0 (0.0%)	0.5	0.0 (0.0%)	0.5	0.0 (0.0%)	0.5	0.0 (0.0%)
November	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)
December	0.8	0.0 (0.0%)	0.8	0.0 (0.0%)	0.7	0.0 (0.0%)	0.8	0.0 (0.0%)
January	0.8	0.0 (0.0%)	0.9	0.0 (0.0%)	0.7	0.0 (0.0%)	0.8	0.0 (0.0%)
February	0.7	0.0 (0.0%)	0.9	0.0 (0.0%)	0.7	0.0 (0.0%)	0.9	0.0 (0.0%)
March	0.6	0.0 (0.0%)	0.9	0.0 (0.0%)	0.6	0.0 (0.0%)	0.8	0.0 (0.0%)
April	0.4	0.0 (0.0%)	0.6	0.0 (0.0%)	0.4	0.0 (0.0%)	0.5	0.0 (0.0%)
May	0.4	0.0 (0.0%)	0.6	0.0 (0.0%)	0.4	0.0 (0.0%)	0.5	0.0 (0.0%)
June	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)
July	0.6	0.0 (0.0%)	0.7	0.0 (0.0%)	0.6	0.0 (0.0%)	0.7	0.0 (0.0%)
August	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)
September	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RMID041)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
mmhos/cm = millimhos per centimeter

Table 7-60. Simulated Number of Months of Exceedence of the Salinity Standard for the Old River near the Middle River Under Baseline Conditions and CP1

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition	CP1 Change	Existing Condition	CP1 Change	No-Action Alternative	CP1 Change	No-Action Alternative	CP1 Change
	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))
October	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
November	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
December	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
January	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
April	2	0.0 (0.0%)	2	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)
May	1	0.0 (0.0%)	1	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
June	1	0.0 (0.0%)	1	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
July	1	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)
August	2	0.0 (0.0%)	2	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RMID041)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan

Impact WQ-19j (CP1): Delta Salinity on the Old River at Tracy Road Bridge
On an average monthly basis, EC would meet requirements in all months in both average years and in dry and critical years under CP1. CP1 would not measurably change EC on the Old River at Tracy Road Bridge. This impact would be less than significant.

As previously mentioned, RD-1641 contains a south Delta water quality requirement applicable at several locations, including on the Old River at Tracy Road Bridge. Table 7-26 details water quality requirement standards for salinity.

CP1 would not measurably change EC on the Old River at Tracy Road Bridge, as shown in Table 7-61. Table 7-62 shows the number of months simulated EC values exceeded the standards for the Old River near Tracy Road Bridge in the period of simulation. Although exceedence would occur during August, under future conditions, on an annual average basis, the compliance of salinity standards under CP1 would not change from the existing conditions. CP1 would not alter the compliance level for the Old River near Tracy Road Bridge observed under both existing and future conditions.

This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-61. Simulated Monthly Average Salinity and Percent Change for the Old River at Tracy Road Bridge Under Baseline Conditions and CP1

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	CP1 Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	CP1 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP1 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP1 Change (mmhos/cm (%))
October	0.5	0.0 (0.2%)	0.6	0.0 (0.2%)	0.5	0.0 (0.1%)	0.5	0.0 (-0.1%)
November	0.6	0.0 (0.1%)	0.6	0.0 (0.1%)	0.6	0.0 (0.1%)	0.6	0.0 (0.0%)
December	0.8	0.0 (0.0%)	0.8	0.0 (0.0%)	0.7	0.0 (0.0%)	0.8	0.0 (0.0%)
January	0.8	0.0 (0.0%)	0.9	0.0 (0.0%)	0.7	0.0 (0.0%)	0.8	0.0 (0.0%)
February	0.7	0.0 (0.0%)	0.9	0.0 (0.0%)	0.7	0.0 (0.0%)	0.9	0.0 (0.0%)
March	0.6	0.0 (0.0%)	0.9	0.0 (0.0%)	0.6	0.0 (0.0%)	0.8	0.0 (0.0%)
April	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)	0.4	0.0 (0.0%)	0.6	0.0 (0.0%)
May	0.4	0.0 (0.0%)	0.6	0.0 (0.0%)	0.4	0.0 (0.0%)	0.5	0.0 (0.0%)
June	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)
July	0.6	0.0 (-0.1%)	0.7	0.0 (-0.3%)	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)
August	0.6	0.0 (-0.1%)	0.6	0.0 (-0.3%)	0.6	0.0 (0.1%)	0.6	0.0 (0.3%)
September	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.5	0.0 (0.1%)	0.6	0.0 (0.2%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node ROLD059)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
mmhos/cm = millimhos per centimeter

Table 7-62. Simulated Number of Months of Exceedence of the Salinity Standard for the Old River at Tracy Road Bridge Under Baseline Conditions and CP1

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition	CP1 Change	Existing Condition	CP1 Change	No-Action Alternative	CP1 Change	No-Action Alternative	CP1 Change
	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))
October	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
November	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
December	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
January	1	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
April	7	0.0 (0.0%)	7	0.0 (0.0%)	5	0.0 (0.0%)	5	0.0 (0.0%)
May	1	0.0 (0.0%)	1	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
June	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
July	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
August	4	0.0 (0.0%)	4	0.0 (0.0%)	3	1.0 (33.3%)	3	1.0 (33.3%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node ROLD059)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index. Percentage values reported in parenthesis are reported as zero if the change is less than one day.

Key:
% = percent
CP = Comprehensive Plan

Impact WQ-20 (CP1): X2 Position CP1 would not change average monthly X2, in either average years or in dry and critical years, by more than 0.1 km under either the existing condition or future condition. Although several months may be out of compliance individually under the bases of comparison, the impact would be less than significant.

Table 7-63 shows the simulated monthly average X2 position for CP1 compared to the existing condition and future condition baselines. CalSim-II calculates the X2 position on a 1-month delay; the values shown have been corrected to accurately reflect the X2 position for the specified month.

This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-63. Simulated Monthly Average X2 Position Under Baseline Conditions and CP1

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (km)	CP1 Change (km (%))	Existing Condition (km)	CP1 Change (km (%))	No-Action Alternative (km)	CP1 Change (km (%))	No-Action Alternative (km)	CP1 Change (km (%))
October	83.9	0.0 (0.0%)	86.6	0.0 (0.0%)	83.9	0.0 (0.0%)	86.5	0.0 (0.0%)
November	82.2	0.1 (0.1%)	86.5	0.0 (0.0%)	82.2	0.1 (0.1%)	86.6	0.0 (0.0%)
December	76.1	0.1 (0.1%)	84.8	0.1 (0.1%)	76.0	0.0 (0.1%)	84.7	0.0 (0.0%)
January	67.5	0.0 (0.0%)	79.6	0.0 (0.0%)	67.3	0.0 (0.1%)	79.2	0.1 (0.2%)
February	60.9	0.0 (0.0%)	72.5	0.0 (0.0%)	60.8	0.0 (0.1%)	72.3	0.1 (0.1%)
March	60.9	0.0 (0.0%)	70.3	0.0 (0.0%)	60.9	0.0 (0.0%)	70.3	0.0 (0.0%)
April	63.5	0.0 (0.0%)	72.9	0.0 (0.0%)	63.4	0.0 (0.0%)	73.0	0.0 (0.0%)
May	67.5	0.0 (0.0%)	77.6	0.0 (0.0%)	67.7	0.0 (0.0%)	78.0	-0.1 (-0.1%)
June	74.5	0.0 (0.0%)	82.6	0.0 (0.0%)	74.7	0.0 (0.0%)	82.8	0.0 (0.0%)
July	80.5	0.0 (0.0%)	86.1	0.0 (0.0%)	80.5	0.0 (0.0%)	86.1	0.0 (0.0%)
August	85.6	0.0 (0.0%)	88.8	0.0 (0.0%)	85.6	0.0 (0.0%)	88.6	0.0 (0.0%)
September	82.6	0.0 (0.0%)	91.1	0.0 (-0.1%)	82.6	0.0 (0.0%)	90.9	-0.1 (-0.1%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node X2_PRV)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
km = kilometer
X2 = geographic location of 2 parts per thousand near-bottom salinity isohaline in the Delta, measured in distance upstream from Golden Gate Bridge in Suisun Bay.

CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

As with CP1, CP2 focuses on increasing water supply reliability and increasing anadromous fish survival. CP2 primarily consists of raising Shasta Dam by 12.5 feet, which, in combination with spillway modifications, would increase the height of the reservoir's full pool by 14.5 feet and enlarge the total storage capacity in the reservoir by 443,000 acre-feet. The existing TCD would also be extended to achieve efficient use of the expanded CWP. Shasta Dam operational guidelines would continue essentially unchanged, except during dry years and critical years, when 120,000 acre-feet and 60,000 acre-feet, respectively, of the increased storage capacity in Shasta Reservoir would be reserved to specifically focus on increasing M&I deliveries. CP2 would help reduce future water shortages through increasing drought year and average year water supply reliability for agricultural and M&I deliveries. In addition, the increased depth and volume of the CWP in Shasta Reservoir would contribute to improving seasonal water temperatures for anadromous fish in the upper Sacramento River.

Shasta Lake and Vicinity

Impact WQ-1 (CP2): Temporary Construction-Related Sediment Effects on Shasta Lake and Its Tributaries that Would Violate Water Quality Standards or Adversely Affect Beneficial Uses This impact is similar to WQ-1 (CP1). However, the construction-related activities described in Chapter 2, "Alternatives," would result in about 500 more acres of exposed shoreline than CP1. Relocation activities under CP2 would expose a similar but greater acreage to erosion than would CP1 (up to 698 acres). This alternative is similar to, but somewhat larger than CP1. Therefore, this impact would be potentially significant. Mitigation for this impact is proposed in Section 7.3.5.

Impact WQ-2 (CP2): Temporary Construction-Related Temperature Effects on Shasta Lake and Its Tributaries that Would Violate Water Quality Standards or Adversely Affect Beneficial Uses Similar to CP1, construction activities associated with enlarging Shasta Dam as well as the relocation actions would result in sizeable areas that would be subject to surface disturbance, including jurisdictional waters within the influence zone of CP2. Efforts to document jurisdictional waters associated with relocation areas are described in Chapter 12, "Botanical Resources and Wetlands." This information has been updated since the DEIS was circulated for public review. If the SLWRI is authorized, Reclamation will work closely with its cooperating agencies to ensure compliance with the CWA (e.g., Section 401 and 404) consistent with the development of the LEDPA.

Environmental commitments and BMPs for the various construction and relocation activities (e.g., bridge replacement, boat ramp construction, demolition of facilities) have been incorporated into CP2. These activities could include removal of riparian vegetation, thereby exposing water bodies to increased solar radiation for various time periods. As described in Chapter 2, "Alternatives," and the "Preliminary Environmental Commitments and Mitigation Plan Appendix," riparian revegetation would be implemented at all construction and relocation sites as applicable to ensure that shade is quickly reestablished after construction is completed.

As described in Chapter 2, "Alternatives," although the TCD may not be operational for some period of time during construction, project sequencing would ensure that changes to water temperature in Shasta Lake and downstream in the upper Sacramento River, as well as associated limnological conditions in Shasta Lake, would be consistent with those that occur periodically under the No-Action Alternative typically associated with maintenance and outage periods.

Because of the large water surface area of Shasta Lake, coupled with the isolated and discrete nature of the relocation activities on the tributaries, temporary construction-related effects are not expected to modify water temperature in a manner that would have a negative effect on beneficial uses or result in a water quality violation. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-3 (CP2): Temporary Construction-Related Metal Effects on Shasta Lake and Its Tributaries that Would Violate Water Quality Standards or Adversely Affect Beneficial Uses This impact is similar to WQ-3 (CP1). There would be no construction activities that would disturb locations known to contain elevated metal concentrations in either sediments or the water column. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-4 (CP2): Long-Term Sediment Effects that Would Violate Water Quality Standards or Adversely Affect Beneficial Uses in Shasta Lake or Its Tributaries This impact is similar to WQ-4 (CP1), except that the exposure of an additional 1,735 acres of shoreline surrounding Shasta Lake would result in a potential for increased wave-related shoreline erosion (see Chapter 4, "Geology, Geomorphology, Minerals, and Soils"). As the reservoir is lowered during summer and fall, the exposed surface area would also be subject to surficial erosion processes that could mobilize and transport sediment to the newly expanded Shasta Lake. Although environmental commitments and BMPs are incorporated into the project description, the project would result in an incremental increase in the delivery of suspended sediment and turbidity to the receiving waters. The amount of sediment that could be delivered is not entirely quantifiable because of the size of the lake and the number of variables that influence sediment transport and delivery. Chapter 4 does provide information on the estimated volume of sediment that may be introduced into Shasta Lake as a result of increases in shoreline erosion. Under CP2, its estimated that about 549,000 cubic yards per year would be delivered to Shasta Lake as a result of shoreline erosion. This would be a potentially significant impact. Mitigation for this impact is proposed in Section 7.3.5.

Impact WQ-5 (CP2): Long-Term Temperature Effects that Would Violate Water Quality Standards or Adversely Affect Beneficial Uses in Shasta Lake or Its Tributaries Similar to CP1, this alternative would increase storage on a monthly basis although it would vary by water year. This impact would be less than significant.

Table 7-64 shows the simulated monthly change in storage for CP2 as a percent increase above the existing condition. On average, CP2 would provide an approximately 10 percent increase in the end-of-month storage on an annual basis.

Table 7-64. Simulated Average Increased End-of-Month Shasta Lake Storage – CP2

Month	Existing Conditions (TAF)	CP2 Change (TAF)	CP2 % Increase
October	2,592	282	10.9%
November	2,568	271	10.6%
December	2,722	295	10.8%
January	2,995	310	10.3%
February	3,267	326	10.0%
March	3,625	334	9.2%
April	3,916	328	8.4%
May	3,941	330	8.4%
June	3,639	327	9.0%
July	3,160	315	10.0%
August	2,834	312	11.0%
September	2,669	301	11.3%

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node S4+S44)

Note:
Simulation period: 1922–2003. Change as measured from Existing Condition.

Key:
% = percent
CP = Comprehensive Plan
TAF = thousand acre-feet

Under CP2, existing water temperature requirements would typically be met in most years; therefore, the additional increase in water storage shown in Table 7-64 would primarily be released for water supply purposes. Accordingly, minimal increases in releases from Shasta Dam would be expected in months when Delta exports are constrained, or when flow is not usable for water supply purposes.

Similar to CP1, the increase in storage provided by CP2 fluctuates greatly throughout a year. A key indicator of water temperature benefits of CP2 to the upper Sacramento River between Keswick Dam and Red Bluff is the amount of cold water available in Shasta Lake before the water temperature operation season, about May through October. Similar to CP1, the CWP volume in the lake accumulates during the winter and early spring and is not likely to increase after April. Therefore, the expected increase in spring storage for CP2 should also result in an incremental increase in the CWP volume.

The simulated end-of-April volume of water with a temperature lower than 52°F for the existing condition and the change in CWP volume for CP2 is shown, by SVI year type, in Table 7-65.

Table 7-65. Simulated Average Volume of Water Less than 52°F in Shasta Lake at the End of April – CP2

SVI Year Type	Existing Conditions (TAF)	CP2 Change (TAF)	% Increase
Average of All Years	2,609	267	10%
Wet	2,916	345	12%
Above Normal	2,972	296	10%
Below Normal	2,699	263	10%
Dry	2,542	231	9%
Critical	1,601	134	8%

Source: BST (Benchmark Study Team) April 2010 version SRWQM 2005 and 2030 simulations

Note:
Simulation period: 1922-2003. Change as measured from Existing Condition.
Year types as defined by the Sacramento Valley Index

Key:
°F = degrees Farenheit
% = percent
CP = Comprehensive Plan
SVI = Sacramento Valley Index
TAF = thousand acre-feet

In addition to illustrating the average change in available CWP, Table 7-65 also shows the influence of climatic conditions on these values. The diversity between water year types, coupled with unique combinations of storage and rainfall would continue to influence the ability to manage storage in Shasta Lake to maximize carryover capacity. An increase in active storage and carryover storage of the CWP would occur. However, the impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-6 (CP2): Long-Term Metals Effects that Would Violate Water Quality Standards or Adversely Affect Beneficial Uses in Shasta Lake or Its Tributaries Similar to CP1, the increase in storage associated with this alternative would not result in modifying the depth and thickness of the thermocline that persists in Shasta Lake. This impact would be less than significant.

Within the Squaw Creek Arm, two depositional features associated with historic copper mining and smelting operations are immediately adjacent to the shoreline of Shasta Lake in the general vicinity of the Bully Hill Mine. As mapped, these two sites appear to have about 7,300 cubic yards of material that could be subjected to shoreline and surficial erosional processes at slightly higher elevations on the features than CP1 with a high potential for delivery to Shasta Lake. This impact would be potentially significant. Mitigation for this impact is proposed in Section 7.3.5.

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact WQ-7 (CP2): Temporary Construction-Related Sediment Effects on the Upper Sacramento River that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses Construction would include ground-disturbing activities that could result in soil erosion and sediment effects on the upper Sacramento River. This impact would be potentially significant.

Similar to Impact WQ-7 (CP1), the impact would be potentially significant. Mitigation for this impact is proposed in Section 7.3.5.

Impact WQ-8 (CP2): Temporary Construction-Related Temperature Effects on the Upper Sacramento River that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses Construction activities are not anticipated to result in temperature effects on the upper Sacramento River because changes to water temperature in Shasta Lake and subsequent releases to the Sacramento River would be consistent with typical periodic fluctuations. This impact would be less than significant.

This impact would be identical to Impact WQ-8 (CP1). For the same reasons as described for Impact WQ-8 (CP1), this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-9 (CP2): Temporary Construction-Related Metal Effects on the Upper Sacramento River that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses Construction activities are not anticipated to result in water quality effects on the upper Sacramento River related to metals because construction would not disturb locations of known elevated metal concentrations. This impact would be less than significant.

This impact would be identical to Impact WQ-9 (CP1). For the same reasons described for Impact WQ-9 (CP1), this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-10 (CP2): Long-Term Sediment Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Upper Sacramento River No long-term water quality impacts are anticipated in the upper Sacramento River in regard to sediment, because modeling results have indicated that CP2 would cause little change in average mean monthly winter flows during some years, which could slightly reduce sediment transport. This impact would be less than significant.

This impact would be similar to Impact WQ-10 (CP1) because the extent of the effect of CP2 on sediment would be similar to but slightly greater than that for CP1 (i.e., CP2 would have greater potential to reduce erosional processes and sediment transport in the upper Sacramento River). For the same reasons as described for Impact WQ-10 (CP1), this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-11 (CP2): Long-Term Temperature Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Upper Sacramento River Analysis of temperature modeling results indicates that CP2 would improve compliance with the temperature requirements on the Sacramento River because of the increased depth of the CWP in Shasta Lake and the associated enhanced ability to regulate water temperature releases to the upper Sacramento River. Therefore, the impact of CP2 on water quality measured as temperature would be beneficial.

CP2 would increase the ability of Shasta Dam to release cold water and regulate water temperature in the upper Sacramento River, primarily in dry and critical years. Raising Shasta Dam 12.5 feet would increase the CWP and benefit seasonal water temperatures along the upper Sacramento River. This section focuses on compliance with water quality standards for temperature. For an analysis of temperature effects on fisheries and aquatic habitat, see Chapter 11, "Fisheries and Aquatic Resources."

Analysis of temperature modeling results indicates that under both existing and future conditions, CP2 would have a beneficial effect on temperature within the upper Sacramento River, with a slight decrease in average monthly water temperature during summer. Decreased temperatures would improve compliance with the temperature objectives for the upper Sacramento River in the 2004 and 2009 NFMS BOs (NMFS 2004, 2009). CP2 would reduce temperature exceedences at Balls Ferry by 15 percent under existing conditions and 19 percent under future conditions. At the Bend Bridge compliance station, CP2 would reduce temperature exceedences by 6 percent under existing conditions and 8 percent under future conditions. Table 7-38 summarizes the temperature modeling results.

Based on this analysis, the impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-12 (CP2): Long-Term Metals Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Upper Sacramento River Long-term operation of the project could result in water quality effects on the upper Sacramento River in regard to metals as a result of erosional processes to historic mining and smelting operation features. This impact would be potentially significant.

This impact would be similar to Impact WQ-12 (CP1) because the extent of the effect of CP2 on metals would be similar to but slightly greater than that for CP1. For the same reasons as described for CP1, this impact would be potentially significant. Mitigation for this impact is proposed in Section 7.3.5.

Lower Sacramento River and Delta and CVP/SWP Service Areas CP2 would differ from the No-Action Alternative primarily through a 443,000 acre-feet enlargement of Shasta Lake. The impacts described below are the same as described for CP1.

Impact WQ-13 (CP2): Temporary Construction-Related Sediment Effects on the Extended Study Area that Would Cause Violations of Water Quality Standards Construction is not anticipated to affect water quality conditions in the extended study area. This impact would be less than significant.

This impact would be similar to Impact WQ-13 (CP1). For the same reasons as described for Impact WQ-13 (CP1), this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-14 (CP2): Temporary Construction-Related Temperature Effects on the Extended Study Area that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses This impact would be similar to Impact WQ-14 (CP1). For the same reasons as described for Impact WQ-14 (CP1), this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-15 (CP2): Temporary Construction-Related Metal Effects on the Extended Study Area that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses This impact would be similar to Impact WQ-15 (CP1). For the same reasons as described for Impact WQ-15 (CP1), this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-16 (CP2): Long-Term Sediment Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Extended Study Area Project implementation could affect water quality in the extended study area, but effects would diminish with distance. This impact would be less than significant.

This impact would be similar to Impact WQ-16 (CP1). For the same reasons as described for Impact WQ-16 (CP1), this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-17 (CP2): Long-Term Temperature Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in *the Extended Study Area* This impact would be similar to Impact WQ-17 (CP1). Analysis of temperature modeling shows little to no change in temperature at RBPP caused by CP2. This suggests that there would be no changes in temperature beyond RBPP as a result of CP2. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-18 (CP2): Long-Term Metals Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Extended Study Area This impact would be similar to Impact WQ-18 (CP1). For the same reasons as described for Impact WQ-18 (CP1), this impact would be potentially significant. Mitigation for this impact is proposed in Section 7.3.5.

Impact WQ-19a (CP2): Delta Salinity on the Sacramento River at Collinsville This impact would be similar to Impact WQ-19a (CP1). As shown in Table 7-66, operations for CP2 result in both increases and decreases in salinity; however, none of the increases would be sufficient to change compliance for the Sacramento River at Collinsville. On a percentage basis, all increases in salinity would be less than 5 percent. This impact would be less than significant.

Table 7-67 shows the number of months simulated EC values exceeded the standards for the Sacramento River at Collinsville in the period of simulation. The operation of CP2 would not result in any violation of the salinity standards under both existing and future conditions. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-66. Simulated Monthly Average Salinity and Percent Change for the Sacramento River at Collinsville Under Baseline Conditions and CP2

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	CP2 Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	CP2 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP2 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP2 Change (mmhos/cm (%))
October	6.0	-0.1 (-1.0%)	7.1	-0.1 (-0.8%)	6.0	-0.1 (-1.0%)	7.1	-0.1 (-0.9%)
November	5.1	0.0 (0.0%)	6.8	0.0 (-0.7%)	5.1	0.0 (-0.1%)	6.9	-0.1 (-0.9%)
December	3.6	0.0 (-0.6%)	5.5	-0.1 (-1.3%)	3.6	0.0 (-0.4%)	5.5	0.0 (-0.7%)
January	1.8	0.0 (0.4%)	3.4	0.0 (1.0%)	1.7	0.0 (-0.1%)	3.3	0.0 (0.3%)
February	0.8	0.0 (2.5%)	1.7	0.1 (3.9%)	0.8	0.0 (0.0%)	1.6	0.0 (0.4%)
March	0.6	0.0 (0.4%)	1.2	0.0 (0.2%)	0.6	0.0 (0.0%)	1.1	0.0 (-0.1%)
April	0.7	0.0 (0.0%)	1.4	0.0 (-0.1%)	0.7	0.0 (-1.0%)	1.5	0.0 (-1.4%)
May	1.1	0.0 (0.0%)	2.3	0.0 (0.1%)	1.1	0.0 (-0.8%)	2.4	0.0 (-1.0%)
June	2.2	0.0 (0.3%)	4.0	0.0 (0.3%)	2.2	0.0 (0.1%)	4.1	0.0 (0.0%)
July	3.2	0.0 (0.0%)	5.3	0.0 (-0.2%)	3.2	0.0 (0.1%)	5.5	0.0 (-0.1%)
August	5.3	0.0 (-0.3%)	7.3	0.0 (-0.7%)	5.4	0.0 (-0.3%)	7.4	0.0 (-0.7%)
September	5.2	0.0 (-0.7%)	8.8	-0.1 (-1.1%)	5.2	-0.1 (-1.3%)	8.8	-0.2 (-2.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAC081)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
mmhos/cm = millimhos per centimeter

Table 7-67. Simulated Number of Months of Exceedence of the Salinity Standard for the Sacramento River at Collinsville Under Baseline Conditions and CP2

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition	CP2 Change	Existing Condition	CP2 Change	No-Action Alternative	CP2 Change	No-Action Alternative	CP2 Change
	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))
October	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
November	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
December	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
January	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
April	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
May	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
June	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
July	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
August	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAC081)

Note:
Simulation period: 1922–2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan

Impact WQ-19b (CP2): Delta Salinity on the San Joaquin River at Jersey Point

Impact WQ-19b (CP2) would be similar to Impact WQ-19b (CP1). As shown in Table 7-68, the basis of comparison would meet the requirement on an average basis in both average years and in dry and critical years. Furthermore, all changes during April through August would be less than 2 percent. This impact would be less than significant.

Table 7-69 shows the number of months simulated EC values exceeded the standards for San Joaquin River at Jersey Point in the period of simulation. CP2 would result in an increase in the frequency of violations under existing conditions during June, by 10 percent in all years and 12.5 percent during dry and critical years. However, the EC standards are not violated on an average monthly basis. Overall, frequency of violation of salinity standards for the San Joaquin River at Jersey Point under CP2 would be similar to those under existing and future conditions. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-68. Simulated Monthly Average Salinity and Percent Change for the San Joaquin River at Jersey Point Under Baseline Conditions and CP2

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	CP2 Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	CP2 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP2 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP2 Change (mmhos/cm (%))
October	1.6	0.0 (-0.5%)	1.8	0.0 (-1.1%)	1.6	0.0 (-0.5%)	1.9	0.0 (-0.7%)
November	1.5	0.0 (1.8%)	1.8	0.0 (1.1%)	1.5	0.0 (1.4%)	1.8	0.0 (0.9%)
December	1.2	0.0 (0.4%)	1.8	0.0 (-0.7%)	1.2	0.0 (0.0%)	1.7	0.0 (-0.8%)
January	0.7	0.0 (0.6%)	1.1	0.0 (1.3%)	0.7	0.0 (0.9%)	1.0	0.0 (2.0%)
February	0.3	0.0 (3.5%)	0.5	0.0 (6.8%)	0.3	0.0 (1.9%)	0.5	0.0 (3.8%)
March	0.3	0.0 (0.8%)	0.3	0.0 (2.0%)	0.3	0.0 (0.4%)	0.3	0.0 (0.9%)
April	0.3	0.0 (0.0%)	0.3	0.0 (0.2%)	0.3	0.0 (-0.1%)	0.3	0.0 (-0.2%)
May	0.3	0.0 (0.0%)	0.4	0.0 (0.1%)	0.3	0.0 (0.0%)	0.4	0.0 (0.0%)
June	0.4	0.0 (0.3%)	0.7	0.0 (0.3%)	0.4	0.0 (0.2%)	0.7	0.0 (0.2%)
July	1.0	0.0 (0.5%)	1.7	0.0 (0.7%)	1.0	0.0 (1.1%)	1.7	0.0 (1.7%)
August	1.6	0.0 (-0.1%)	2.2	0.0 (-0.2%)	1.6	0.0 (0.1%)	2.1	0.0 (0.5%)
September	1.9	0.0 (0.3%)	2.8	0.0 (0.6%)	1.9	0.0 (0.6%)	2.8	0.0 (1.1%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAN018)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
mmhos/cm = millimhos per centimeter

Table 7-69. Simulated Number of Months of Exceedence of the Salinity Standard for the San Joaquin River at Jersey Point Under Baseline Conditions and CP2

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition	CP2 Change	Existing Condition	CP2 Change	No-Action Alternative	CP2 Change	No-Action Alternative	CP2 Change
	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))
October	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
November	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
December	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
January	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
April	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
May	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
June	10	1.0 (10.0%)	8	1.0 (12.5%)	13	0.0 (0.0%)	11	0.0 (0.0%)
July	51	0.0 (0.0%)	22	0.0 (0.0%)	50	1.0 (2.0%)	21	1.0 (4.8%)
August	73	0.0 (0.0%)	25	0.0 (0.0%)	76	-2.0 (-2.6%)	27	-2.0 (-7.4%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAN018)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan

Impact WQ-19c (CP2): Delta Salinity on the Sacramento River at Emmaton
Impact WQ-19c (CP2) would be similar to Impact WQ-19c (CP1). Operations for CP2 would result in both increases and decreases in salinity in comparison to baseline conditions; however, none of the increases would be sufficient to change compliance for the Sacramento River at Emmaton. On a percentage basis, all increases in salinity would be less than 5 percent. This impact would be less than significant.

Although Table 7-70 shows EC for all months, the Emmaton water quality requirement is only defined for April 1 through August 15. On an average monthly basis, EC requirements would be satisfied in all months in an average year under CP2 operations. Maximum change in monthly EC would not be greater than 5 percent under both existing and future conditions. Table 7-71 shows the number of months simulated EC values exceeded the standards for the Sacramento River at Emmaton in the period of simulation. Operations of CP2 would not result in any violation of salinity standards between October and March. CP2 would result in an increase in the frequency of violations under existing and future Conditions during May, by up to 100 percent in all years and dry and critical years. However, CP2 would result in a decrease in the frequency of violations under existing and future conditions during August and April, by up to 50 percent in all years and dry and critical years.

On an average monthly basis, the standards are not violated. Overall, the compliance of salinity standards for the Sacramento River at Emmaton would be very similar to the baseline levels under both existing and future conditions. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-70. Simulated Monthly Average Salinity and Percent Change for the Sacramento River at Emmaton Under Baseline Conditions and CP2

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	CP2 Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	CP2 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP2 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP2 Change (mmhos/cm (%))
October	2.0	0.0 (-1.9%)	2.4	0.0 (-1.6%)	2.0	0.0 (-2.0%)	2.5	0.0 (-1.7%)
November	1.5	0.0 (-0.9%)	2.2	0.0 (-1.7%)	1.5	0.0 (-1.1%)	2.3	0.0 (-2.1%)
December	1.0	0.0 (-1.7%)	1.5	0.0 (-3.0%)	0.9	0.0 (-0.9%)	1.5	0.0 (-1.5%)
January	0.5	0.0 (0.9%)	0.7	0.0 (1.9%)	0.4	0.0 (0.0%)	0.7	0.0 (0.4%)
February	0.3	0.0 (2.3%)	0.4	0.0 (4.7%)	0.3	0.0 (0.3%)	0.4	0.0 (0.8%)
March	0.2	0.0 (0.4%)	0.3	0.0 (0.8%)	0.2	0.0 (0.3%)	0.3	0.0 (0.6%)
April	0.3	0.0 (-0.1%)	0.3	0.0 (0.0%)	0.3	0.0 (-0.5%)	0.4	0.0 (-1.0%)
May	0.3	0.0 (0.0%)	0.5	0.0 (0.1%)	0.3	0.0 (-0.6%)	0.6	0.0 (-0.9%)
June	0.6	0.0 (0.3%)	1.1	0.0 (0.4%)	0.6	0.0 (0.2%)	1.1	0.0 (0.2%)
July	0.7	0.0 (-0.4%)	1.3	0.0 (-0.8%)	0.8	0.0 (-0.5%)	1.4	0.0 (-0.9%)
August	1.4	0.0 (-0.6%)	2.3	0.0 (-1.2%)	1.5	0.0 (-0.7%)	2.3	0.0 (-1.3%)
September	1.6	0.0 (-1.9%)	3.0	-0.1 (-2.7%)	1.6	-0.1 (-3.1%)	3.1	-0.1 (-4.3%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAC092)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
mmhos/cm = millimhos per centimeter

Table 7-71. Simulated Number of Months of Exceedence of the Salinity Standard for the Sacramento River at Emmaton Under Baseline Conditions and CP2

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years			
	Existing Condition	CP2 Change	Existing Condition	CP2 Change	No-Action Alternative	CP2 Change	No-Action Alternative	
	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	
October	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
November	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
December	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
January	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
April	1	0.0 (0.0%)	1	0.0 (0.0%)	2	-1.0 (-50.0%)	2	-1.0 (-50.0%)
May	1	1.0 (100.0%)	1	1.0 (100.0%)	3	1.0 (33.3%)	3	1.0 (33.3%)
June	28	0.0 (0.0%)	18	0.0 (0.0%)	27	0.0 (0.0%)	19	0.0 (0.0%)
July	1	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)
August	69	-3.0 (-4.3%)	26	-3.0 (-11.5%)	70	-2.0 (-2.9%)	26	-2.0 (-7.7%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAC092)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan

Impact WQ-19d (CP2): Delta Salinity on the Old River at Rock Slough Impact WQ-19d (CP2) would be similar to Impact WQ-19d (CP1). On an average annual basis, chloride levels under both the existing condition and future condition would be less than 150 mg/L from February through July. This impact would be less than significant.

As shown in Table 7-72, in average annual years, CP2 would not increase chlorides by more than 1.3 percent. For dry and critical years, a maximum change of 2.3 percent in chloride concentration would occur. Change in chloride concentration would not affect compliance with the standard as it would already be exceeded under the basis of comparison. This impact would be less than significant.

Table 7-73 shows the number of days simulated chloride values exceeded the standards of 150 mg/L for Contra Costa Canal Pumping Plant No. 1 in the period of simulation. CP2 would result in no daily violations of the chloride standards under both existing and future conditions for CP2. Overall, CP2 would not alter the compliance level observed under the existing and future conditions.

This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-72. Simulated Monthly Average Chlorides and Percent Change for Contra Costa Canal Pumping Plant No. 1 Under Baseline Conditions and CP2

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mg/L)	CP2 Change (mg/L (%))	Existing Condition (mg/L)	CP2 Change (mg/L (%))	No-Action Alternative (mg/L)	CP2 Change (mg/L (%))	No-Action Alternative (mg/L)	CP2 Change (mg/L (%))
October	156.2	-0.3 (-0.2%)	175.6	-1.1 (-0.6%)	157.1	-0.4 (-0.3%)	176.7	-0.9 (-0.5%)
November	154.9	-0.9 (-0.6%)	177.7	-1.7 (-0.9%)	155.3	-0.5 (-0.3%)	181.1	-1.0 (-0.6%)
December	144.3	1.9 (1.3%)	178.3	1.6 (0.9%)	151.7	0.0 (0.0%)	186.7	0.3 (0.2%)
January	153.9	1.2 (0.8%)	183.5	2.2 (1.2%)	164.9	0.6 (0.4%)	197.1	0.7 (0.4%)
February	106.2	0.8 (0.8%)	112.3	2.6 (2.3%)	119.2	1.1 (0.9%)	115.5	2.5 (2.1%)
March	95.2	0.2 (0.2%)	92.3	1.7 (1.9%)	103.8	0.9 (0.9%)	95.6	1.6 (1.7%)
April	88.4	-0.4 (-0.5%)	86.6	0.3 (0.4%)	90.0	0.3 (0.4%)	85.4	0.6 (0.6%)
May	90.4	-0.2 (-0.2%)	92.3	0.1 (0.1%)	87.5	0.1 (0.1%)	87.2	0.1 (0.1%)
June	62.4	0.0 (0.0%)	75.8	0.1 (0.1%)	61.5	0.0 (0.1%)	75.4	0.1 (0.2%)
July	73.8	0.3 (0.4%)	111.3	0.8 (0.7%)	76.6	0.5 (0.6%)	115.5	1.3 (1.1%)
August	117.0	0.2 (0.2%)	182.4	0.6 (0.4%)	122.0	0.7 (0.6%)	186.3	2.2 (1.2%)
September	158.5	-0.2 (-0.2%)	210.3	-0.4 (-0.2%)	167.1	-0.4 (-0.2%)	208.4	-0.4 (-0.2%)

*Source: Version 8.0.6, DSM2 Existing and Future simulations EC at Old River at Rock Slough (Node CHCCC006) converted to chlorides at Contra Costa Canal Pumping Plant No. 1 using the equation EC*0.268-24*

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
EC = electrical conductivity
mg/L = milligrams per liter

Table 7-73. Simulated Number of Days by Month of Exceedence of the Chloride Standard for Contra Costa Canal Pumping Plant No. 1 Under Baseline Conditions and CP2

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition	CP2 Change	Existing Condition	CP2 Change	No-Action Alternative	CP2 Change	No-Action Alternative	CP2 Change
	(Number of days)	(Number of days (%))	(Number of days)	(Number of days (%))	(Number of days)	(Number of days (%))	(Number of days)	(Number of days (%))
October	17	0 (0%)	7	0 (0%)	17	0 (0%)	7	0 (0%)
November	16	0 (0%)	7	0 (0%)	16	0 (0%)	7	0 (0%)
December	14	0 (0%)	7	0 (0%)	15	0 (0%)	7	0 (0%)
January	13	0 (0%)	7	0 (0%)	16	0 (0%)	8	0 (0%)
February	5	0 (0%)	2	0 (0%)	7	0 (0%)	2	0 (0%)
March	3	0 (0%)	1	0 (0%)	5	0 (0%)	0	0 (0%)
April	1	0 (0%)	0	0 (0%)	1	0 (0%)	0	0 (0%)
May	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
June	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
July	3	0 (0%)	3	0 (0%)	3	0 (0%)	3	0 (0%)
August	10	0 (0%)	10	0 (0%)	11	0 (0%)	10	0 (0%)
September	18	0 (0%)	11	0 (0%)	20	0 (0%)	11	0 (0%)
Total	99	0 (0%)	54	0 (0%)	111	0 (0%)	56	0 (0%)

*Source: Version 8.0.6, DSM2 Existing and Future simulations EC at Old River at Rock Slough (Node CHCCC006) converted to chlorides at Contra Costa Canal Pumping Plant No. 1 using the equation EC*0.268-24*

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.
Percentage values reported in parenthesis are reported as zero if the change is less than one day.

Key:
% = percent
CP = Comprehensive Plan
EC = electrical conductivity

Impact WQ-19e (CP2): Delta Water Quality on the Delta-Mendota Canal at Jones Pumping Plant Impact WQ-19e (CP2) would be similar to Impact WQ-19e (CP1). The water quality requirement on the Delta-Mendota Canal at Jones Pumping Plant has two components, a chloride requirement and an EC requirement. This impact would be less than significant.

Tables 7-74 and 7-75 show that CP2 would not exceed chloride thresholds. All increases in chloride concentrations would be less than 5 percent. Chloride values under CP2 would be similar to the baseline values under both existing and future conditions. Tables 7-76 and 7-77 show that increases in EC would be less than 5 percent under CP2 and would not exceed the EC threshold. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-74. Simulated Monthly Average Chlorides and Percent Change for the Delta-Mendota Canal at the Jones Pumping Plant Under Baseline Conditions and CP2

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Conditio n (mg/L)	CP2 Change (mg/L (%))	Existing Condition (mg/L)	CP2 Change (mg/L (%))	No-Action Alternative (mg/L)	CP2 Change (mg/L (%))	No-Action Alternative (mg/L)	CP2 Change (mg/L (%))
October	107.1	-0.5 (-0.4%)	117.9	-1.0 (-0.9%)	105.1	-0.6 (-0.6%)	117.0	-1.2 (-1.0%)
November	105.8	-0.2 (-0.2%)	118.9	-0.5 (-0.4%)	103.1	-0.5 (-0.5%)	118.4	-1.2 (-1.0%)
December	124.1	1.1 (0.9%)	142.3	0.9 (0.7%)	118.1	0.4 (0.4%)	136.7	0.4 (0.3%)
January	141.4	-0.3 (-0.2%)	165.9	-1.0 (-0.6%)	129.5	0.1 (0.0%)	151.2	0.3 (0.2%)
February	123.6	0.1 (0.1%)	159.4	0.2 (0.1%)	113.7	0.2 (0.2%)	148.2	0.6 (0.4%)
March	106.9	-0.5 (-0.5%)	157.9	-0.4 (-0.3%)	97.1	0.3 (0.4%)	146.9	0.9 (0.6%)
April	84.0	0.0 (0.0%)	123.4	0.1 (0.1%)	68.6	0.2 (0.3%)	108.4	0.5 (0.4%)
May	75.3	0.0 (0.0%)	106.4	0.0 (0.0%)	66.0	0.0 (0.0%)	97.7	0.0 (0.0%)
June	66.4	0.0 (-0.1%)	81.4	0.1 (0.2%)	60.8	0.0 (0.0%)	75.6	0.3 (0.4%)
July	60.8	0.3 (0.5%)	83.1	0.7 (0.9%)	58.8	0.3 (0.6%)	82.1	0.8 (1.0%)
August	82.2	0.4 (0.4%)	121.9	1.0 (0.8%)	80.6	0.5 (0.6%)	121.2	1.6 (1.3%)
September	109.5	0.1 (0.1%)	145.0	0.5 (0.4%)	107.5	0.0 (0.0%)	141.7	0.4 (0.3%)

*Source: Version 8.0.6, DSM2 Existing and Future simulations (Node CHCDMC006) converted to chlorides using the equation EC*0.273-43.9)*

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
EC = electrical conductivity
mg/L = milligrams per liter

Table 7-75. Simulated Number of Days by Month of Exceedence of the Chloride Standard for the Delta-Mendota Canal at the Jones Pumping Plant Under Baseline Conditions and CP2

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition	CP2 Change	Existing Condition	CP2 Change	No-Action Alternative	CP2 Change	No-Action Alternative	CP2 Change
	(Number of days)	(Number of days (%))	(Number of days)	(Number of days (%))	(Number of days)	(Number of days (%))	(Number of days)	(Number of days (%))
October	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
November	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
December	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
January	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
February	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
March	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
April	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
May	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
June	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
July	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
August	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
September	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
Total	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node CHCDMC006)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.
Percentage values reported in parenthesis are reported as zero if the change is less than one day.

Key:
% = percent
CP = Comprehensive Plan

Table 7-76. Simulated Monthly Average Salinity and Percent Change for the Delta-Mendota Canal at the Jones Pumping Plant Under Baseline Conditions and CP2

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	CP2 Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	CP2 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP2 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP2 Change (mmhos/cm (%))
October	0.6	0.0 (-0.3%)	0.6	0.0 (-0.6%)	0.5	0.0 (-0.4%)	0.6	0.0 (-0.8%)
November	0.5	0.0 (-0.1%)	0.6	0.0 (-0.3%)	0.5	0.0 (-0.4%)	0.6	0.0 (-0.7%)
December	0.6	0.0 (0.6%)	0.7	0.0 (0.5%)	0.6	0.0 (0.3%)	0.7	0.0 (0.2%)
January	0.7	0.0 (-0.2%)	0.8	0.0 (-0.5%)	0.6	0.0 (0.0%)	0.7	0.0 (0.2%)
February	0.6	0.0 (0.1%)	0.7	0.0 (0.1%)	0.6	0.0 (0.1%)	0.7	0.0 (0.3%)
March	0.6	0.0 (-0.4%)	0.7	0.0 (-0.2%)	0.5	0.0 (0.2%)	0.7	0.0 (0.5%)
April	0.5	0.0 (0.0%)	0.6	0.0 (0.1%)	0.4	0.0 (0.2%)	0.6	0.0 (0.3%)
May	0.4	0.0 (0.0%)	0.6	0.0 (0.0%)	0.4	0.0 (0.0%)	0.5	0.0 (0.0%)
June	0.4	0.0 (0.0%)	0.5	0.0 (0.1%)	0.4	0.0 (0.0%)	0.4	0.0 (0.3%)
July	0.4	0.0 (0.3%)	0.5	0.0 (0.6%)	0.4	0.0 (0.3%)	0.5	0.0 (0.6%)
August	0.5	0.0 (0.3%)	0.6	0.0 (0.6%)	0.5	0.0 (0.4%)	0.6	0.0 (1.0%)
September	0.6	0.0 (0.1%)	0.7	0.0 (0.3%)	0.6	0.0 (0.0%)	0.7	0.0 (0.2%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node CHCDMC006)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
mmhos/cm = millimhos per centimeter

Table 7-77. Simulated Number of Months of Exceedence of the Salinity Standard for the Delta-Mendota Canal at the Jones Pumping Plant Under Baseline Conditions and CP2

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition	CP2 Change	Existing Condition	CP2 Change	No-Action Alternative	CP2 Change	No-Action Alternative	CP2 Change
	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))
October	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
November	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
December	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
January	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
April	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
May	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
June	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
July	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
August	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node CHCDMC006)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan

Impact WQ-19f (CP2): Delta Water Quality in the West Canal at the Mouth of the Clifton Court Forebay Impact WQ-19f (CP2) would be similar to Impact WQ-19f (CP1). The 250-mg/L chloride concentration standard at the West Canal would not be exceeded on an average annual or dry and critical year basis under CP2. CP2 would also not exceed EC thresholds. This impact would be less than significant.

Table 7-78 shows that maximum chloride concentrations under both existing and future project conditions are lower for CP2 than the 250 mg/L threshold. Maximum changes under both existing and future projection conditions are less than 1.5 percent. As shown in Table 7-79, CP2 the maximum change in EC values under existing and future project conditions would be less than 1.5 percent.

Table 7-78. Simulated Monthly Average Chlorides and Percent Change for West Canal at the Clifton Court Forebay Under Baseline Conditions and CP2

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mg/L)	CP2 Change (mg/L (%))	Existing Condition (mg/L)	CP2 Change (mg/L (%))	No-Action Alternative (mg/L)	CP2 Change (mg/L (%))	No-Action Alternative (mg/L)	CP2 Change (mg/L (%))
October	110.8	-0.5 (-0.5%)	124.3	-1.1 (-0.9%)	110.4	-0.6 (-0.6%)	125.1	-1.2 (-1.0%)
November	107.2	0.1 (0.1%)	123.4	-0.5 (-0.4%)	105.7	-0.2 (-0.2%)	124.8	-1.0 (-0.8%)
December	109.2	1.6 (1.5%)	131.8	1.2 (0.9%)	107.0	0.7 (0.6%)	131.1	0.3 (0.3%)
January	128.1	0.0 (0.0%)	154.3	-0.4 (-0.3%)	120.5	0.0 (0.0%)	145.3	0.0 (0.0%)
February	107.5	0.1 (0.1%)	134.7	0.5 (0.4%)	99.2	0.4 (0.4%)	124.2	1.6 (1.3%)
March	91.9	-0.3 (-0.3%)	132.1	0.4 (0.3%)	83.6	0.7 (0.8%)	122.4	1.7 (1.4%)
April	75.6	0.0 (0.0%)	110.3	0.2 (0.2%)	60.8	0.3 (0.6%)	96.4	0.9 (1.0%)
May	70.8	0.0 (0.0%)	99.9	0.0 (0.0%)	61.6	0.0 (0.1%)	91.6	0.1 (0.1%)
June	56.4	0.0 (-0.1%)	73.4	0.1 (0.1%)	51.8	0.0 (0.0%)	68.6	0.2 (0.4%)
July	52.2	0.3 (0.6%)	82.6	0.8 (1.0%)	51.3	0.3 (0.6%)	82.3	0.8 (1.0%)
August	80.5	0.0 (0.0%)	128.2	0.2 (0.2%)	80.4	0.5 (0.6%)	127.5	1.7 (1.3%)
September	115.0	0.1 (0.1%)	157.5	0.4 (0.3%)	114.9	0.0 (0.0%)	154.7	0.6 (0.4%)

*Source: Version 8.0.6, DSM2 Existing and Future simulations (Node CHSWP003) converted to chlorides using the equation EC*0.273-43.9)*

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
EC = electrical conductivity
mg/L = milligrams per liter

Table 7-79. Simulated Monthly Average Salinity and Percent Change for West Canal at the Clifton Court Forebay Under Baseline Conditions and CP2

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	CP2 Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	CP2 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP2 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP2 Change (mmhos/cm (%))
October	0.6	0.0 (-0.3%)	0.6	0.0 (-0.7%)	0.6	0.0 (-0.4%)	0.6	0.0 (-0.7%)
November	0.6	0.0 (0.1%)	0.6	0.0 (-0.3%)	0.5	0.0 (-0.1%)	0.6	0.0 (-0.6%)
December	0.6	0.0 (1.0%)	0.6	0.0 (0.7%)	0.6	0.0 (0.4%)	0.6	0.0 (0.2%)
January	0.6	0.0 (0.0%)	0.7	0.0 (-0.2%)	0.6	0.0 (0.0%)	0.7	0.0 (0.0%)
February	0.6	0.0 (0.1%)	0.7	0.0 (0.3%)	0.5	0.0 (0.3%)	0.6	0.0 (0.9%)
March	0.5	0.0 (-0.2%)	0.6	0.0 (0.2%)	0.5	0.0 (0.5%)	0.6	0.0 (1.0%)
April	0.4	0.0 (0.0%)	0.6	0.0 (0.1%)	0.4	0.0 (0.3%)	0.5	0.0 (0.7%)
May	0.4	0.0 (0.0%)	0.5	0.0 (0.0%)	0.4	0.0 (0.0%)	0.5	0.0 (0.1%)
June	0.4	0.0 (0.0%)	0.4	0.0 (0.1%)	0.4	0.0 (0.0%)	0.4	0.0 (0.2%)
July	0.4	0.0 (0.3%)	0.5	0.0 (0.6%)	0.3	0.0 (0.3%)	0.5	0.0 (0.7%)
August	0.5	0.0 (0.0%)	0.6	0.0 (0.1%)	0.5	0.0 (0.4%)	0.6	0.0 (1.0%)
September	0.6	0.0 (0.1%)	0.7	0.0 (0.2%)	0.6	0.0 (0.0%)	0.7	0.0 (0.3%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node CHSWP003)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
mmhos/cm = millimhos per centimeter

Table 7-80 shows the average number of days simulated chloride values exceeded the standards of 250 mg/L for the West Canal at the Clifton Court Forebay in a year. There would be no additional violations throughout the year under both existing and future project conditions. CP2 would not change the baseline compliance levels under both existing and future conditions.

As shown in Table 7-81, CP2 would not result in any additional violations of the salinity standards. CP2 would actually result in decreases in EC during several months of the year. CP2 would not change the baseline compliance levels under both existing and future conditions.

Overall, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-80. Simulated Number of Days by Month of Exceedence of the Chloride Standard for the West Canal at the Clifton Court Forebay Under Baseline Conditions and CP2

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition	CP2 Change	Existing Condition	CP2 Change	No-Action Alternative	CP2 Change	No-Action Alternative	CP2 Change
	(Number of days)	(Number of days (%))	(Number of days)	(Number of days (%))	(Number of days)	(Number of days (%))	(Number of days)	(Number of days (%))
October	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
November	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
December	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
January	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
February	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
March	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
April	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
May	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
June	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
July	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
August	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
September	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
Total	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node CHSWP003)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.
Percentage values reported in parenthesis are reported as zero if the change is less than one day.

Key:
% = percent
CP = Comprehensive Plan

Table 7-81. Simulated Number of Months of Exceedence of the Salinity Standard for the West Canal at the Clifton Court Forebay Under Baseline Conditions and CP2

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition	CP2 Change	Existing Condition	CP2 Change	No-Action Alternative	CP2 Change	No-Action Alternative	CP2 Change
	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))
October	0	0.0 (0.0%)	0	0.0 (0.0%)	1	0.0 (0.0%)	0	0.0 (0.0%)
November	0	1.0 (0.0%)	0	0.0 (0.0%)	3	-3.0 (-100.0%)	2	-2.0 (-100.0%)
December	0	0.0 (0.0%)	0	0.0 (0.0%)	2	-1.0 (-50.0%)	1	0.0 (0.0%)
January	1	-1.0 (-100.0%)	1	-1.0 (-100.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
April	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
May	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
June	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
July	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
August	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node CHSWP003)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan

Impact WQ-19g (CP2): Delta Salinity on the San Joaquin River at Vernalis

This impact would be similar to Impact WQ-19g (CP1). On an average monthly basis, EC would meet requirements in all months, in both average years and in dry and critical years. CP2 would not exceed EC thresholds on the San Joaquin River at Vernalis as shown in Tables 7-82 and 7-83. CP2 would not change the baseline compliance levels under both existing and future conditions. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-82. Simulated Monthly Average Salinity and Percent Change for the San Joaquin River at Vernalis Under Baseline Conditions and CP2

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	CP2 Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	CP2 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP2 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP2 Change (mmhos/cm (%))
October	0.5	0.0 (0.0%)	0.5	0.0 (0.0%)	0.5	0.0 (0.0%)	0.5	0.0 (0.0%)
November	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)
December	0.8	0.0 (0.0%)	0.8	0.0 (0.0%)	0.7	0.0 (0.0%)	0.8	0.0 (0.0%)
January	0.8	0.0 (0.0%)	0.9	0.0 (0.0%)	0.7	0.0 (0.0%)	0.8	0.0 (0.0%)
February	0.7	0.0 (0.0%)	0.9	0.0 (0.0%)	0.7	0.0 (0.0%)	0.9	0.0 (0.0%)
March	0.6	0.0 (0.0%)	0.9	0.0 (0.0%)	0.6	0.0 (0.0%)	0.8	0.0 (0.0%)
April	0.4	0.0 (0.0%)	0.6	0.0 (0.0%)	0.4	0.0 (0.0%)	0.5	0.0 (0.0%)
May	0.4	0.0 (0.0%)	0.5	0.0 (0.0%)	0.4	0.0 (0.0%)	0.5	0.0 (0.0%)
June	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)
July	0.6	0.0 (0.0%)	0.7	0.0 (0.0%)	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)
August	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)
September	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAN112)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
mmhos/cm = millimhos per centimeter

Table 7-83. Simulated Number of Months of Exceedence of the Salinity Standard for the San Joaquin River at Vernalis Under Baseline Conditions and CP2

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition (Number of months)	CP2 Change (Number of months (%))	Existing Condition (Number of months)	CP2 Change (Number of months (%))	No-Action Alternative (Number of months)	CP2 Change (Number of months (%))	No-Action Alternative (Number of months)	CP2 Change (Number of months (%))
October	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
November	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
December	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
January	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
April	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
May	1	0.0 (0.0%)	1	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
June	1	0.0 (0.0%)	1	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
July	1	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)
August	3	0.0 (0.0%)	3	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAN112)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan

Impact WQ-19h (CP2): Delta Salinity on the San Joaquin River at Brandt Bridge Impact WQ-19h (CP2) would be similar to Impact WQ-19h (CP1). On an average monthly basis, EC would meet requirements in all months in both average years and in dry and critical years, as shown in Table 7-84. CP2 would not measurably change EC on the San Joaquin River at Brandt Bridge. This impact would be less than significant.

Table 7-85 shows the number of months simulated EC values exceeded the standards for the San Joaquin River at Brandt Bridge in the period of simulation. CP2 would not change the existing compliance level for salinity standards for the San Joaquin River at Brandt Bridge. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-84. Simulated Monthly Average Salinity and Percent Change for the San Joaquin River at Brandt Bridge Under Baseline Conditions and CP2

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	CP2 Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	CP2 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP2 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP2 Change (mmhos/cm (%))
October	0.5	0.0 (0.0%)	0.5	0.0 (0.0%)	0.5	0.0 (0.0%)	0.5	0.0 (0.0%)
November	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)
December	0.8	0.0 (0.0%)	0.8	0.0 (0.0%)	0.7	0.0 (0.0%)	0.8	0.0 (0.0%)
January	0.8	0.0 (0.0%)	0.9	0.0 (0.0%)	0.7	0.0 (0.0%)	0.8	0.0 (0.0%)
February	0.7	0.0 (0.0%)	0.9	0.0 (0.0%)	0.7	0.0 (0.0%)	0.9	0.0 (0.0%)
March	0.6	0.0 (0.0%)	0.9	0.0 (0.0%)	0.6	0.0 (0.0%)	0.8	0.0 (0.0%)
April	0.4	0.0 (0.0%)	0.6	0.0 (0.0%)	0.4	0.0 (0.0%)	0.5	0.0 (0.0%)
May	0.4	0.0 (0.0%)	0.6	0.0 (0.0%)	0.4	0.0 (0.0%)	0.5	0.0 (0.0%)
June	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)
July	0.6	0.0 (0.0%)	0.7	0.0 (0.1%)	0.6	0.0 (0.0%)	0.7	0.0 (0.0%)
August	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)
September	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAN112)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
mmhos/cm = millimhos per centimeter

Table 7-85. Simulated Number of Months of Exceedence of the Salinity Standard for the San Joaquin River at Brandt Bridge Under Baseline Conditions and CP2

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition	CP2 Change	Existing Condition	CP2 Change	No-Action Alternative	CP2 Change	No-Action Alternative	CP2 Change
	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))
October	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
November	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
December	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
January	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
April	2	0.0 (0.0%)	2	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)
May	1	0.0 (0.0%)	1	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
June	1	0.0 (0.0%)	1	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
July	1	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)
August	2	0.0 (0.0%)	2	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAN112)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan

Impact WQ-19i (CP2): Delta Salinity on the Old River near the Middle River
Impact WQ-19i (CP2) would be similar to Impact WQ-19i (CP1). On an average monthly basis, EC would meet requirements in all months in both average years and in dry and critical years. CP2 would not measurably change EC on the Old River near the Middle River, as shown in Table 7-86. This impact would be less than significant.

Table 7-87 shows the number of months simulated EC values exceeded the standards for the Old River near the Middle River in the period of simulation. Compliance with salinity standards for the Old River near the Middle River would not change under CP2 when compared to the existing conditions. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-86. Simulated Monthly Average Salinity and Percent Change for the Old River near Middle River Under Baseline Conditions and CP2

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	CP2 Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	CP2 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP2 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP2 Change (mmhos/cm (%))
October	0.5	0.0 (0.0%)	0.5	0.0 (0.0%)	0.5	0.0 (0.0%)	0.5	0.0 (0.0%)
November	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)
December	0.8	0.0 (0.0%)	0.8	0.0 (0.0%)	0.7	0.0 (0.0%)	0.8	0.0 (0.0%)
January	0.8	0.0 (0.0%)	0.9	0.0 (0.0%)	0.7	0.0 (0.0%)	0.8	0.0 (0.0%)
February	0.7	0.0 (0.0%)	0.9	0.0 (0.0%)	0.7	0.0 (0.0%)	0.9	0.0 (0.0%)
March	0.6	0.0 (0.0%)	0.9	0.0 (0.0%)	0.6	0.0 (0.0%)	0.8	0.0 (0.0%)
April	0.4	0.0 (0.0%)	0.6	0.0 (0.0%)	0.4	0.0 (0.0%)	0.5	0.0 (0.0%)
May	0.4	0.0 (0.0%)	0.6	0.0 (0.0%)	0.4	0.0 (0.0%)	0.5	0.0 (0.0%)
June	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)
July	0.6	0.0 (0.0%)	0.7	0.0 (0.0%)	0.6	0.0 (0.0%)	0.7	0.0 (0.0%)
August	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)
September	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RMID041)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
mmhos/cm = millimhos per centimeter

Table 7-87. Simulated Number of Months of Exceedence of the Salinity Standard for the Old River near Middle River Under Baseline Conditions and CP2

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition	CP2 Change	Existing Condition	CP2 Change	No-Action Alternative	CP2 Change	No-Action Alternative	CP2 Change
	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))
October	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
November	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
December	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
January	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
April	2	0.0 (0.0%)	2	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)
May	1	0.0 (0.0%)	1	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
June	1	0.0 (0.0%)	1	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
July	1	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)
August	2	0.0 (0.0%)	2	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RMID041)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan

Impact WQ-19j (CP2): Delta Salinity on the Old River at Tracy Road Bridge
Impact WQ-19j (CP2) would be similar to Impact WQ-19j (CP1). On an average monthly basis, EC would meet requirements in all months in both average years and in dry and critical years. CP2 would not measurably change EC on the Old River at Tracy Road Bridge, as shown in Table 7-88. This impact would be less than significant.

Table 7-89 shows the number of months simulated EC values exceeded the standards for the Old River near Tracy Road Bridge. Although exceedence would occur during August, under future conditions, on an annual average basis, the compliance of salinity standards under CP2 would not change from the existing conditions. Overall, CP2 would not change the baseline compliance levels under both existing and future conditions. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-88. Simulated Monthly Average Salinity and Percent Change for the Old River at Tracy Road Bridge Under Baseline Conditions and CP2

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	CP2 Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	CP2 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP2 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP2 Change (mmhos/cm (%))
October	0.5	0.0 (0.2%)	0.6	0.0 (0.3%)	0.5	0.0 (0.2%)	0.5	0.0 (0.1%)
November	0.6	0.0 (0.1%)	0.6	0.0 (0.1%)	0.6	0.0 (0.1%)	0.6	0.0 (0.1%)
December	0.8	0.0 (0.0%)	0.8	0.0 (0.0%)	0.7	0.0 (0.0%)	0.8	0.0 (0.0%)
January	0.8	0.0 (0.0%)	0.9	0.0 (0.0%)	0.7	0.0 (0.0%)	0.8	0.0 (0.0%)
February	0.7	0.0 (0.0%)	0.9	0.0 (0.0%)	0.7	0.0 (0.0%)	0.9	0.0 (0.0%)
March	0.6	0.0 (0.0%)	0.9	0.0 (0.0%)	0.6	0.0 (0.0%)	0.8	0.0 (0.0%)
April	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)	0.4	0.0 (0.0%)	0.6	0.0 (0.0%)
May	0.4	0.0 (0.0%)	0.6	0.0 (0.0%)	0.4	0.0 (0.0%)	0.5	0.0 (0.0%)
June	0.5	0.0 (0.0%)	0.6	0.0 (0.1%)	0.5	0.0 (0.0%)	0.6	0.0 (0.1%)
July	0.6	0.0 (0.0%)	0.7	0.0 (0.1%)	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)
August	0.6	0.0 (-0.1%)	0.6	0.0 (-0.3%)	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)
September	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.5	0.0 (0.1%)	0.6	0.0 (0.1%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node ROLD059)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
mmhos/cm = millimhos per centimeter

Table 7-89. Simulated Number of Months of Exceedence of the Salinity Standard for the Old River at Tracy Road Bridge Under Baseline Conditions and CP2

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition	CP2 Change	Existing Condition	CP2 Change	No-Action Alternative	CP2 Change	No-Action Alternative	CP2 Change
	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))
October	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
November	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
December	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
January	1	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
April	7	0.0 (0.0%)	7	0.0 (0.0%)	5	0.0 (0.0%)	5	0.0 (0.0%)
May	1	0.0 (0.0%)	1	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
June	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
July	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
August	4	0.0 (0.0%)	4	0.0 (0.0%)	3	1.0 (33.3%)	3	1.0 (33.3%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node ROLD059)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan

Impact WQ-20 (CP2): X2 Position CP2 would not change average monthly X2 in either average years or in dry and critical years by more than 0.1 km under either the existing condition or future condition. Although several months may be out of compliance individually under the bases of comparison, the impact would be less than significant.

Impact WQ-20 (CP2) would be similar to Impact WQ-20 (CP1). Table 7-90 shows the simulated monthly average X2 position for CP2 as compared to the existing condition and future condition baselines. CalSim-II calculates the X2 position on a 1-month delay; the values shown have been corrected to accurately reflect the X2 position for the specified month.

This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-90. Simulated Monthly Average X2 Position Under Baseline Conditions and CP2

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (km)	CP2 Change (km (%))	Existing Condition (km)	CP2 Change (mmhos/cm (%))	No-Action Alternative (km)	CP2 Change (km (%))	No-Action Alternative (km)	CP2 Change (km (%))
October	83.9	0.0 (-0.1%)	86.6	-0.1 (-0.1%)	83.9	-0.1 (-0.1%)	86.5	-0.1 (-0.1%)
November	82.2	0.1 (0.1%)	86.5	0.0 (0.0%)	82.2	0.1 (0.1%)	86.6	0.0 (0.0%)
December	76.1	0.0 (0.1%)	84.8	-0.1 (-0.1%)	76.0	0.1 (0.1%)	84.7	0.0 (0.0%)
January	67.5	0.0 (0.0%)	79.6	0.1 (0.1%)	67.3	0.0 (0.0%)	79.2	0.0 (0.1%)
February	60.9	0.1 (0.1%)	72.5	0.1 (0.2%)	60.8	0.0 (0.0%)	72.3	0.0 (0.1%)
March	60.9	0.0 (0.1%)	70.3	0.0 (0.0%)	60.9	0.0 (0.0%)	70.3	0.0 (0.0%)
April	63.5	0.0 (0.0%)	72.9	0.0 (0.0%)	63.4	0.0 (0.0%)	73.0	-0.1 (-0.1%)
May	67.5	0.0 (0.0%)	77.6	0.0 (0.0%)	67.7	0.0 (0.0%)	78.0	-0.1 (-0.1%)
June	74.5	0.0 (0.1%)	82.6	0.0 (0.0%)	74.7	0.0 (0.0%)	82.8	0.0 (0.0%)
July	80.5	0.0 (0.0%)	86.1	0.0 (0.0%)	80.5	0.0 (0.0%)	86.1	0.0 (0.0%)
August	85.6	0.0 (0.0%)	88.8	-0.1 (-0.1%)	85.6	0.0 (0.0%)	88.6	-0.1 (-0.1%)
September	82.6	0.0 (0.0%)	91.1	-0.1 (-0.1%)	82.6	-0.1 (-0.1%)	90.9	-0.2 (-0.2%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node X2_PRV)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
km = kilometer
X2 = geographic location of 2 parts per thousand near-bottom salinity isohaline in the Delta, measured in distance upstream from Golden Gate Bridge in Suisun Bay.

CP3 – 18.5-Foot Dam Raise, Agricultural Water Supply Reliability and Anadromous Fish Survival

CP3 focuses on increasing agricultural water supply reliability while also increasing anadromous fish survival. This plan primarily consists of raising Shasta Dam by 18.5 feet, which, in combination with spillway modifications, would increase the height of the reservoir's full pool by 20.5 feet and enlarge the total storage capacity in the reservoir by 634,000 acre-feet. The existing TCD would also be extended to achieve efficient use of the expanded CWP. Because CP3 focuses on increasing agricultural water supply reliability, none of the increased storage capacity in Shasta Reservoir would be reserved for increasing M&I deliveries. Operations for water supply, hydropower, and environmental and other regulatory requirements would be similar to existing operations, with the additional storage retained for water supply reliability and to expand the CWP for downstream anadromous fisheries.

Simulations of CP3 did not involve any changes to the modeling logic for deliveries or flow requirements; all rules for water operations were updated to include the new storage, but were not otherwise changed.

Shasta Lake and Vicinity

Impact WQ-1 (CP3): Temporary Construction-Related Sediment Effects on Shasta Lake and Its Tributaries that Would Violate Water Quality Standards or Adversely Affect Beneficial Uses This impact is similar to WQ-1 (CP1). However, the construction-related activities described in Chapter 2, "Alternatives," would result in about 1,270 more acres of exposed shoreline than CP1. Relocation activities under CP3 would expose a similar but greater acreage to erosion than would CP2 (up to 698 acres). This impact would be potentially significant. Mitigation for this impact is proposed in Section 7.3.5.

Impact WQ-2 (CP3): Temporary Construction-Related Temperature Effects on Shasta Lake and Its Tributaries that Would Violate Water Quality Standards or Adversely Affect Beneficial Uses Similar to CP1, construction activities associated with enlarging Shasta Dam as well as the relocation actions would result in sizeable areas that would be subject to surface disturbance, including jurisdictional waters within the influence zone of CP3. Efforts to document jurisdictional waters associated with relocation areas are described in Chapter 12, "Botanical Resources and Wetlands." This information has been updated since the DEIS was circulated for public review. If the SLWRI is authorized, Reclamation will work closely with its cooperating agencies to ensure compliance with the CWA (e.g., Section 401 and 404) consistent with the development of the LEDPA.

Environmental commitments and BMPs for the various construction and relocation activities (e.g., bridge replacement, boat ramp construction, demolition of facilities) have been incorporated into CP3. These activities could include removal of riparian vegetation, thereby exposing water bodies to increased solar radiation for various time periods. As described in Chapter 2, "Alternatives," and the "Preliminary Environmental Commitments and Mitigation Plan Appendix," riparian revegetation would be implemented at all construction and relocation sites as applicable to ensure that shade is quickly reestablished after construction is completed. As described in Chapter 2, "Alternatives," although the TCD may not be operational for some period of time during construction, project sequencing would ensure that changes to water temperature in Shasta Lake and downstream in the upper Sacramento River, as well as associated limnological conditions in Shasta Lake would be consistent with those that occur periodically under the No-Action Alternative typically associated with maintenance and outage periods.

Because of the large water surface area of Shasta Lake, coupled with the isolated and discrete nature of the relocation activities on the tributaries, temporary construction-related effects are not expected to modify water temperature in a manner that would have a negative effect on beneficial uses or result in a water quality violation. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-3 (CP3): Temporary Construction-Related Metal Effects on Shasta Lake and Its Tributaries that Would Violate Water Quality Standards or Adversely Affect Beneficial Uses This impact is similar to WQ-3 (CP1). No construction activities would disturb locations known to contain elevated metal concentrations in either sediments or the water column. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-4 (CP3): Long-Term Sediment Effects that Would Violate Water Quality Standards or Adversely Affect Beneficial Uses in Shasta Lake or Its Tributaries This impact is similar to WQ4 (CP1), except that the exposure of about 2,498 acres of shoreline surrounding Shasta Lake would result in a potential for increased wave-related shoreline erosion compared to the No-Action Alternative (see Attachment 1, "Shoreline Erosion Technical Memorandum," to Appendix 7, "Geologic Technical Report"). As the reservoir is lowered during summer and fall, the exposed surface area would also be subject to surficial erosion processes that could mobilize and transport sediment to the newly expanded Shasta Lake. Although environmental commitments and BMPs are incorporated into the project description, the project would result in an incremental increase in the delivery of suspended sediment and turbidity to the receiving waters. The amount of sediment that could be delivered is not entirely quantifiable because of the size of the lake and the number of variables that influence sediment transport and delivery. Chapter 4, "Geology, Geomorphology, Minerals, and Soils," does provide information on the estimated volume of sediment that may be introduced into Shasta Lake as a result of increases in shoreline erosion. Under CP3, it's estimated that about 767,000 cubic yards per year would be delivered to Shasta Lake as a result of shoreline erosion. Therefore, this impact is potentially significant. Mitigation for this impact is proposed in Section 7.3.5.

Impact WQ-5 (CP3): Long-Term Temperature Effects that Would Violate Water Quality Standards or Adversely Affect Beneficial Uses in Shasta Lake or Its Tributaries Similar to CP1, this alternative would increase storage on a monthly basis, although it would vary by water year. This impact would be less than significant.

Table 7-91 illustrates the monthly change in simulated storage for CP3 as a percent increase above the existing condition. On average, CP3 represents an approximately 14 percent increase in the end-of-month storage on an annual basis.

Table 7-91. Simulated Average Increased End-of-Month Shasta Lake Storage – CP3

Month	Existing Conditions (TAF)	CP3 Change (TAF)	CP3 % Increase
October	2,592	399	15.4%
November	2,568	390	15.2%
December	2,722	424	15.6%
January	2,995	440	14.7%
February	3,267	457	14.0%
March	3,625	468	12.9%
April	3,916	459	11.7%
May	3,941	459	11.7%
June	3,639	455	12.5%
July	3,160	442	14.0%
August	2,834	431	15.2%
September	2,669	420	15.7%

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node S4+S44)

Note:
Simulation period: 1922-2003. Change as measured from Existing Condition.

Key:
% = percent
CP = Comprehensive Plan
TAF = thousand acre-feet

Under CP3, existing water temperature requirements would typically be met in most years; therefore, the additional increase in water storage shown in Table 7-91 would primarily be released for water supply purposes. Accordingly, minimal increases in releases from Shasta Dam would be expected in months when Delta exports are constrained, or when flow is not usable for water supply purposes.

Similar to CP1, the increase in storage provided by CP3 fluctuates greatly throughout a year. A key indicator of water temperature benefits of CP3 to the upper Sacramento River between Keswick Dam and Red Bluff is the amount of cold water available in Shasta Lake before the water temperature operation season, about May through October. Similar to CP1, the CWP volume in the lake accumulates during winter and early spring and is not likely to increase after April. Therefore, the expected increase in spring storage for CP3 should also result in an incremental increase in the CWP volume.

The simulated end-of-April volume of water with a temperature lower than 52°F for the existing condition and the change in CWP volume for CP3 is shown, by SVI, in Table 7-92.

Table 7-92. Simulated Average Volume of Water Less than 52°F in Shasta Lake at the End of April – CP3

SVI Year Type	Existing Conditions (TAF)	CP3 Change (TAF)	% Increase
Average of All Years	2,609	385	15%
Wet	2,916	520	18%
Above Normal	2,972	432	15%
Below Normal	2,699	382	14%
Dry	2,542	322	13%
Critical	1,601	151	9%

Source: BST (Benchmark Study Team) April 2010 version SRWQM 2005 and 2030 simulations

Note:
Simulation period: 1922-2003. Change as measured from Existing Condition.
Year types as defined by the Sacramento Valley Index

Key:
°F = degrees Farenheit
% = percent
CP = Comprehensive Plan
SVI = Sacramento Valley Index
TAF = thousand acre-feet

In addition to illustrating the average change in available CWP, Table 7-92 also shows the influence of climatic conditions on these values. The diversity between water year types, coupled with unique combinations of storage and rainfall, would continue to influence the ability to manage storage in Shasta Lake to maximize carryover capacity. Although an increase in active storage and carryover storage of the CWP would occur, the impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-6 (CP3): Long-Term Metals Effects that Would Violate Water Quality Standards or Adversely Affect Beneficial Uses in Shasta Lake or Its Tributaries Similar to CP1, the increase in storage associated with this alternative would not result in modifying the depth and thickness of the thermocline that persists in Shasta Lake. This impact would be potentially significant.

Within the Squaw Creek Arm, two depositional features associated with historic copper mining and smelting operations are immediately adjacent to the shoreline of Shasta Lake in the general vicinity of the Bully Hill Mine. As mapped, these two sites appear to have about 7,300 cubic yards of material that could be subjected to shoreline and surficial erosional processes with an increase in reservoir elevations related to CP3.

The impact would be potentially significant. Mitigation for this impact is proposed in Section 7.3.5.

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact WQ-7 (CP3): Temporary Construction-Related Sediment Effects on the Upper Sacramento River that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses Construction would include ground-disturbing activities that could result in soil erosion and sediment effects on the upper Sacramento River. This impact would be potentially significant.

This impact would be the same as Impact WQ-7 (CP1) and would be potentially significant. Mitigation for this impact is proposed in Section 7.3.5.

Impact WQ-8 (CP3): Temporary Construction-Related Temperature Effects on the Upper Sacramento River that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses Construction activities are not anticipated to result in temperature effects on the upper Sacramento River because changes to water temperature in Shasta Lake and subsequent releases to the Sacramento River would be consistent with typical periodic fluctuations. This impact would be less than significant.

This impact would be identical to Impact WQ-8 (CP1). For the same reasons as described for Impact WQ-8 (CP1), this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-9 (CP3): Temporary Construction-Related Metal Effects on the Upper Sacramento River that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses Construction activities are not anticipated to result in water quality effects on the upper Sacramento River related to metals because construction would not disturb locations of known elevated metal concentrations. This impact would be less than significant.

This impact would be identical to Impact WQ-9 (CP1). For the same reasons as described for Impact WQ-9 (CP1), the impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-10 (CP3): Long-Term Sediment Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Upper Sacramento River No long-term water quality impacts are anticipated in the upper Sacramento River in regard to sediment, because modeling results have indicated that CP3 would cause little change in average mean monthly flow, and could cause a decrease in peak flows that are associated with increased sediment transport. This impact would be less than significant.

This impact would be similar to Impact WQ-10 (CP1) because the extent of the effect of CP3 on sediment would be similar to that for CP1. For the same reasons as described for Impact WQ-10 (CP1), the impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-11 (CP3): Long-Term Temperature Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Upper Sacramento River Analysis of temperature modeling results indicates that CP3 would improve compliance with the temperature requirements on the Sacramento River because of the increased depth of the CWP in Shasta Lake and the associated enhanced ability to regulate water temperature releases to the upper Sacramento River. Therefore, the impact on water quality measured as temperature would be beneficial.

CP3 would increase the ability of Shasta Dam to release cold water and regulate water temperature in the upper Sacramento River, primarily in dry and critical years. Raising Shasta Dam 18.5 feet would increase the CWP and benefit seasonal water temperatures along the upper Sacramento River. This section focuses on compliance with water quality standards for temperature. For an analysis of temperature effects on fisheries and aquatic habitat, see Chapter 11, "Fisheries and Aquatic Resources."

Analysis of temperature modeling results indicates that CP3 would have a beneficial effect on temperature within the upper Sacramento River, with a slight decrease in average monthly water temperature during summer under both existing and future conditions. Decreased temperatures would improve compliance with the temperature objectives for the upper Sacramento River in the 2009 NMFS BO. CP3 would reduce temperature exceedences at Balls Ferry by 18 percent under existing conditions and 24 percent under future conditions. At the Bend Bridge compliance station, CP3 would reduce temperature exceedences by 8 percent under existing conditions and 11 percent under future conditions. Table 7-38 summarizes the temperature modeling results.

The impact on water quality measured as temperature would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-12 (CP3): Long-Term Metals Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Upper Sacramento River Long-term operation of the project could result in water quality effects on the upper Sacramento River in regard to metals as a result of erosional processes related to historic mining and smelting operation features. This impact would be potentially significant.

This impact would be similar to Impact WQ-12 (CP3) because the extent of the effect of CP3 on metals would be similar to that for CP1. For the same reasons as described for Impact WQ-12 (CP1), the impact would be potentially significant. Mitigation for this impact is proposed in Section 7.3.5.

Lower Sacramento River and Delta and CVP/SWP Service Areas

Impact WQ-13 (CP3): Temporary Construction-Related Sediment Effects on the Extended Study Area that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses Construction is not anticipated to affect water quality conditions in the extended study area. This impact would be less than significant.

This impact would be similar to Impact WQ-13 (CP1). For the same reasons described for Impact WQ-13 (CP1), the impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-14 (CP3): Temporary Construction-Related Temperature Effects on the Extended Study Area that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses This impact would be similar to Impact WQ-14 (CP1). For the same reasons described for Impact WQ-14 (CP1), the impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-15 (CP3): Temporary Construction-Related Metal Effects on the Extended Study Area that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses This impact would be similar to Impact WQ-15 (CP1). For the same reasons described for Impact WQ-15 (CP1), the impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-16 (CP3): Long-Term Sediment Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Extended Study Area Project implementation could affect water quality in the extended study area, but effects would diminish with distance. This impact would be less than significant.

This impact would be similar to Impact WQ-16 (CP1). For the same reasons as described for Impact WQ-16 (CP1), the impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-17 (CP3): Long-Term Temperature Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Extended Study Area This impact would be similar to Impact WQ-17 (CP1). Analysis of temperature modeling shows little to no change in temperature at RBPP caused by CP3. This suggests that no changes in temperature would occur beyond RBPP. The impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-18 (CP3): Long-Term Metals Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Extended Study Area This impact would be similar to Impact WQ-18 (CP1). For the same reasons as described for Impact WQ-18 (CP1), the impact would be potentially significant. Mitigation for this impact is proposed in Section 7.3.5.

Impact WQ-19a (CP3): Delta Salinity on the Sacramento River at Collinsville Similar to WQ-19a (CP1) and WQ-19a (CP2), and as shown in Table 7-93, operations for CP3 would result in both increases and decreases in salinity; however, none of the increases would be sufficient to change compliance for the Sacramento River at Collinsville. On a percentage basis, all increases in salinity would be less than 5 percent. The impact would be less than significant.

Table 7-94 shows the number of months simulated EC values exceeded the standards for the Sacramento River at Collinsville in the period of simulation. The operation of CP3 would not result in any violation of the salinity standards under both existing and future conditions. The impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-93. Simulated Monthly Average Salinity and Percent Change for the Sacramento River at Collinsville Under Baseline Conditions and CP3

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	CP3 Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	CP3 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP3 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP3 Change (mmhos/cm (%))
October	6.0	0.0 (-0.3%)	7.1	0.0 (0.1%)	6.0	0.0 (-0.4%)	7.1	0.0 (-0.4%)
November	5.1	0.0 (0.4%)	6.8	0.0 (-0.2%)	5.1	0.0 (0.3%)	6.9	0.0 (-0.4%)
December	3.6	0.0 (0.0%)	5.5	0.0 (-0.3%)	3.6	0.0 (-1.3%)	5.5	-0.1 (-2.1%)
January	1.8	0.0 (0.6%)	3.4	0.0 (1.3%)	1.7	0.0 (-0.6%)	3.3	0.0 (-0.3%)
February	0.8	0.0 (0.7%)	1.7	0.0 (1.6%)	0.8	0.0 (1.4%)	1.6	0.0 (2.3%)
March	0.6	0.0 (0.1%)	1.2	0.0 (0.1%)	0.6	0.0 (0.6%)	1.1	0.0 (0.6%)
April	0.7	0.0 (-0.9%)	1.4	0.0 (-1.1%)	0.7	0.0 (-1.2%)	1.5	0.0 (-1.6%)
May	1.1	0.0 (-0.9%)	2.3	0.0 (-0.8%)	1.1	0.0 (-1.8%)	2.4	0.0 (-2.0%)
June	2.2	0.0 (-0.4%)	4.0	0.0 (-0.6%)	2.2	0.0 (-0.4%)	4.1	0.0 (-0.8%)
July	3.2	0.0 (-0.2%)	5.3	0.0 (-0.4%)	3.2	0.0 (-0.2%)	5.5	0.0 (-0.6%)
August	5.3	0.0 (0.1%)	7.3	0.0 (0.1%)	5.4	0.0 (-0.2%)	7.4	0.0 (-0.4%)
September	5.2	0.0 (0.1%)	8.8	0.0 (0.2%)	5.2	0.0 (-0.5%)	8.8	-0.1 (-0.6%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAC081)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
mmhos/cm = millimhos per centimeter

Table 7-94. Simulated Number of Months of Exceedence of the Salinity Standard for the Old River at Collinsville Under Baseline Conditions and CP3

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition	CP3 Change	Existing Condition	CP3 Change	No-Action Alternative	CP3 Change	No-Action Alternative	CP3 Change
	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))
October	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
November	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
December	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
January	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
April	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
May	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
June	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
July	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
August	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAC081)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan

Impact WQ-19b (CP3): Delta Salinity on the San Joaquin River at Jersey Point
Impact WQ-19b (CP3) would be similar to Impact WQ-19b (CP1). Operations for CP3 would result in both increases and decreases in salinity in comparison with baseline conditions; however, none of the increases would be sufficient to change compliance for the San Joaquin River at Jersey Point. On a percentage basis, all increases in salinity would be less than 5 percent. The impact would be less than significant.

As shown in Table 7-95, the basis of comparison would meet the requirement on an average basis in both average years and in dry and critical years. Furthermore, all changes during April through August would be less than 1 percent.

Table 7-96 shows the number of months simulated EC values exceeded the standards for the San Joaquin River at Jersey Point in the period of simulation. No exceedences were shown, and CP3 would actually result in a decrease in the frequency of violations under existing conditions during July: by 2 percent in all years and 4.5 percent during dry and critical years.

Overall, the impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-95. Simulated Monthly Average Salinity and Percent Change for the San Joaquin River at Jersey Point Under Baseline Conditions and CP3

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	CP3 Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	CP3 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP3 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP3 Change (mmhos/cm (%))
October	1.6	0.0 (0.4%)	1.8	0.0 (0.7%)	1.6	0.0 (0.4%)	1.9	0.0 (0.0%)
November	1.5	0.0 (1.7%)	1.8	0.0 (1.4%)	1.5	0.0 (2.1%)	1.8	0.0 (1.7%)
December	1.2	0.0 (0.9%)	1.8	0.0 (0.2%)	1.2	0.0 (-1.2%)	1.7	-0.1 (-3.4%)
January	0.7	0.0 (1.7%)	1.1	0.0 (3.2%)	0.7	0.0 (-0.5%)	1.0	0.0 (-0.4%)
February	0.3	0.0 (2.2%)	0.5	0.0 (4.4%)	0.3	0.0 (2.6%)	0.5	0.0 (5.2%)
March	0.3	0.0 (0.3%)	0.3	0.0 (1.1%)	0.3	0.0 (0.8%)	0.3	0.0 (1.8%)
April	0.3	0.0 (-0.2%)	0.3	0.0 (-0.1%)	0.3	0.0 (-0.1%)	0.3	0.0 (-0.3%)
May	0.3	0.0 (-0.2%)	0.4	0.0 (-0.2%)	0.3	0.0 (-0.8%)	0.4	0.0 (-1.6%)
June	0.4	0.0 (-0.3%)	0.7	0.0 (-0.4%)	0.4	0.0 (-0.6%)	0.7	0.0 (-1.0%)
July	1.0	0.0 (-0.3%)	1.7	0.0 (-0.6%)	1.0	0.0 (0.2%)	1.7	0.0 (0.1%)
August	1.6	0.0 (0.1%)	2.2	0.0 (0.1%)	1.6	0.0 (0.6%)	2.1	0.0 (1.1%)
September	1.9	0.0 (0.5%)	2.8	0.0 (0.3%)	1.9	0.0 (0.5%)	2.8	0.0 (0.4%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAN018)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
mmhos/cm = millimhos per centimeter

Table 7-96. Simulated Number of Months of Exceedence of the Salinity Standard for the San Joaquin River at Jersey Point Under Baseline Conditions and CP3

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition	CP3 Change	Existing Condition	CP3 Change	No-Action Alternative	CP3 Change	No-Action Alternative	CP3 Change
	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))
October	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
November	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
December	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
January	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
April	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
May	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
June	10	0.0 (0.0%)	8	0.0 (0.0%)	13	0.0 (0.0%)	11	0.0 (0.0%)
July	51	-1.0 (-2.0%)	22	-1.0 (-4.5%)	50	0.0 (0.0%)	21	0.0 (0.0%)
August	73	0.0 (0.0%)	25	0.0 (0.0%)	76	0.0 (0.0%)	27	0.0 (0.0%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAN018)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan

Impact WQ-19c (CP3): Delta Salinity on the Sacramento River at Emmaton
On an average monthly basis, EC would meet the requirements in all months on an average annual basis; moreover, CP3 would not increase the EC at Emmaton during this period by more than 2.8 percent. This impact would be less than significant.

Impact WQ-19c (CP3) would be similar to Impact WQ-19c (CP1). Although Table 7-97 shows EC for all months, the Emmaton water quality requirement is only defined for April 1 through August 15. On an average monthly basis, EC would meet the requirements in all months on an average annual basis. Table 7-98 shows the number of months simulated EC values exceeded the standards for the Sacramento River at Emmaton in the period of simulation. CP3 would result in an increase in the frequency of violations under existing and future conditions during May, by up to 33.3 percent in all years and dry and critical years. However, CP3 would result in a decrease in the frequency of violations under existing and future conditions during April, June, and August by up to 50 percent in the average of all years and dry and critical years. Overall, the compliance of salinity standards for the Sacramento River at Emmaton would be very similar to the baseline levels under both existing and future conditions.

The impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-97. Simulated Monthly Average Salinity and Percent Change for the Sacramento River at Emmaton Under Baseline Conditions and CP3

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	CP3 Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	CP3 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP3 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP3 Change (mmhos/cm (%))
October	2.0	0.0 (-0.8%)	2.4	0.0 (-0.1%)	2.0	0.0 (-1.1%)	2.5	0.0 (-0.8%)
November	1.5	0.0 (0.1%)	2.2	0.0 (-0.7%)	1.5	0.0 (-0.5%)	2.3	0.0 (-1.3%)
December	1.0	0.0 (-0.8%)	1.5	0.0 (-1.3%)	0.9	0.0 (-2.3%)	1.5	0.0 (-3.2%)
January	0.5	0.0 (0.8%)	0.7	0.0 (1.7%)	0.4	0.0 (-0.1%)	0.7	0.0 (0.3%)
February	0.3	0.0 (1.0%)	0.4	0.0 (2.3%)	0.3	0.0 (1.3%)	0.4	0.0 (2.8%)
March	0.2	0.0 (0.3%)	0.3	0.0 (0.6%)	0.2	0.0 (0.6%)	0.3	0.0 (1.2%)
April	0.3	0.0 (-0.5%)	0.3	0.0 (-0.7%)	0.3	0.0 (-0.7%)	0.4	0.0 (-1.3%)
May	0.3	0.0 (-0.4%)	0.5	0.0 (-0.5%)	0.3	0.0 (-1.3%)	0.6	0.0 (-1.9%)
June	0.6	0.0 (-0.4%)	1.1	0.0 (-0.6%)	0.6	0.0 (-0.6%)	1.1	0.0 (-0.9%)
July	0.7	0.0 (-0.3%)	1.3	0.0 (-0.5%)	0.8	0.0 (-0.7%)	1.4	0.0 (-1.3%)
August	1.4	0.0 (0.2%)	2.3	0.0 (0.1%)	1.5	0.0 (-0.7%)	2.3	0.0 (-1.2%)
September	1.6	0.0 (0.2%)	3.0	0.0 (0.4%)	1.6	0.0 (-1.0%)	3.1	0.0 (-1.1%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAC092)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
mmhos/cm = millimhos per centimeter

Table 7-98. Simulated Number of Months of Exceedence of the Salinity Standard for the Sacramento River at Emmaton Under Baseline Conditions and CP3

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition	CP3 Change	Existing Condition	CP3 Change	No-Action Alternative	CP3 Change	No-Action Alternative	CP3 Change
	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))
October	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
November	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
December	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
January	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
April	1	0.0 (0.0%)	1	0.0 (0.0%)	2	-1.0 (-50.0%)	2	-1.0 (-50.0%)
May	1	0.0 (0.0%)	1	0.0 (0.0%)	3	1.0 (33.3%)	3	1.0 (33.3%)
June	28	-1.0 (-3.6%)	18	0.0 (0.0%)	27	0.0 (0.0%)	19	0.0 (0.0%)
July	1	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)
August	69	-1.0 (-1.4%)	26	-1.0 (-3.8%)	70	-1.0 (-1.4%)	26	-1.0 (-3.8%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAC092)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan

Impact WQ-19d (CP3): Delta Salinity on the Old River at Rock Slough Impact WQ-19d (CP3) would be similar to Impact WQ-19d (CP1). On an average annual basis, chloride levels under both the existing condition and future condition would be less than 150 mg/L from February through July. This impact would be less than significant.

Table 7-99 shows that in average annual years, CP3 would not increase chlorides by more than 1.2 percent. For dry and critical years, a maximum change of 2.5 percent in chloride concentration would occur. Change in chloride concentration would not affect compliance with the standard; it would already be exceeded under the basis of comparison. This impact would be less than significant.

Table 7-100 shows the number of days in a year when simulated chloride values exceeded the standards of 150 mg/L for Contra Costa Canal Pumping Plant No. 1. No daily violations of the chloride standards would occur under both existing and future conditions under CP3. Overall, CP3 would not alter the compliance level observed under both existing and future conditions. The impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-99. Simulated Monthly Average Chlorides and Percent Change for Contra Costa Canal Pumping Plant No. 1 Under Baseline Conditions and CP3

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mg/L)	CP3 Change (mg/L (%))	Existing Condition (mg/L)	CP3 Change (mg/L (%))	No-Action Alternative (mg/L)	CP3 Change (mg/L (%))	No-Action Alternative (mg/L)	CP3 Change (mg/L (%))
October	156.2	0.4 (0.3%)	175.6	0.8 (0.4%)	157.1	0.1 (0.1%)	176.7	-0.1 (0.0%)
November	154.9	0.4 (0.2%)	177.7	1.0 (0.6%)	155.3	0.6 (0.4%)	181.1	-0.2 (-0.1%)
December	144.3	1.8 (1.2%)	178.3	1.6 (0.9%)	151.7	1.1 (0.8%)	186.7	1.6 (0.9%)
January	153.9	1.3 (0.9%)	183.5	2.9 (1.6%)	164.9	-0.9 (-0.6%)	197.1	-3.1 (-1.6%)
February	106.2	0.5 (0.5%)	112.3	2.8 (2.5%)	119.2	0.2 (0.2%)	115.5	0.8 (0.7%)
March	95.2	-0.6 (-0.6%)	92.3	1.5 (1.6%)	103.8	0.4 (0.4%)	95.6	1.0 (1.0%)
April	88.4	-0.3 (-0.3%)	86.6	0.5 (0.6%)	90.0	0.2 (0.2%)	85.4	0.4 (0.4%)
May	90.4	-0.1 (-0.2%)	92.3	0.2 (0.2%)	87.5	0.2 (0.2%)	87.2	0.4 (0.5%)
June	62.4	0.0 (-0.1%)	75.8	0.0 (0.0%)	61.5	-0.2 (-0.3%)	75.4	-0.4 (-0.5%)
July	73.8	-0.1 (-0.2%)	111.3	-0.5 (-0.4%)	76.6	0.1 (0.1%)	115.5	-0.1 (-0.1%)
August	117.0	-0.2 (-0.1%)	182.4	-0.7 (-0.4%)	122.0	0.2 (0.2%)	186.3	0.4 (0.2%)
September	158.5	0.6 (0.4%)	210.3	0.6 (0.3%)	167.1	0.9 (0.5%)	208.4	1.2 (0.6%)

*Source: Version 8.0.6, DSM2 Existing and Future simulations EC at Old River at Rock Slough (Node CHCCC006) converted to chlorides at Contra Costa Canal Pumping Plant No. 1 using the equation EC*0.268-24*

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
EC = electrical conductivity
mg/L = milligrams per liter

Table 7-100. Simulated Number of Days by Month of Exceedence of the Chloride Standard for Contra Costa Canal Pumping Plant No. 1 Under Baseline Conditions and CP3

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition	CP3 Change	Existing Condition	CP3 Change	No-Action Alternative	CP3 Change	No-Action Alternative	CP3 Change
	(Number of days)	(Number of days (%))	(Number of days)	(Number of days (%))	(Number of days)	(Number of days (%))	(Number of days)	(Number of days (%))
October	17	0 (0%)	7	0 (0%)	17	0 (0%)	7	0 (0%)
November	16	0 (0%)	7	0 (0%)	16	0 (0%)	7	0 (0%)
December	14	0 (0%)	7	0 (0%)	15	0 (0%)	7	0 (0%)
January	13	0 (0%)	7	0 (0%)	16	0 (0%)	8	0 (0%)
February	5	0 (0%)	2	0 (0%)	7	0 (0%)	2	0 (0%)
March	3	0 (0%)	1	0 (0%)	5	0 (0%)	0	0 (0%)
April	1	0 (0%)	0	0 (0%)	1	0 (0%)	0	0 (0%)
May	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
June	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
July	3	0 (0%)	3	0 (0%)	3	0 (0%)	3	0 (0%)
August	10	0 (0%)	10	0 (0%)	11	0 (0%)	10	0 (0%)
September	18	0 (0%)	11	0 (0%)	20	0 (0%)	11	0 (0%)
Total	99	0 (0%)	54	0 (0%)	111	0 (0%)	56	0 (0%)

*Source: Version 8.0.6, DSM2 Existing and Future simulations EC at Old River at Rock Slough (Node CHCCC006) converted to chlorides at Contra Costa Canal Pumping Plant No. 1 using the equation EC*0.268-24*

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.
Percentage values reported in parenthesis are reported as zero if the change is less than one day.

Key:
% = percent
CP = Comprehensive Plan
EC = electrical conductivity

Impact WQ-19e (CP3): Delta Water Quality on the Delta-Mendota Canal at Jones Pumping Plant This impact would be similar to Impact WQ-19e (CP1). The water quality requirement on the Delta-Mendota Canal at Jones Pumping Plant has two components, a chloride requirement and an EC requirement. Tables 7-101 and 7-102 show that CP3 would not cause exceedence of chloride thresholds. All increases in chloride concentrations would be less than 5 percent. Chloride values under CP3 would be similar to the baseline values under both existing and future conditions. Tables 7-103 and 7-104 show that increases in EC would be less 5 percent under CP3 and would not exceed the EC threshold. The impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-101. Simulated Monthly Average Chlorides and Percent Change for the Delta-Mendota Canal at the Jones Pumping Plant Under Baseline Conditions and CP3

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mg/L)	CP3 Change (mg/L (%))	Existing Condition (mg/L)	CP3 Change (mg/L (%))	No-Action Alternative (mg/L)	CP3 Change (mg/L (%))	No-Action Alternative (mg/L)	CP3 Change (mg/L (%))
October	107.1	0.2 (0.2%)	117.9	0.1 (0.1%)	105.1	-0.1 (-0.1%)	117.0	-0.7 (-0.6%)
November	105.8	-0.1 (-0.1%)	118.9	0.1 (0.1%)	103.1	0.0 (0.0%)	118.4	-0.8 (-0.7%)
December	124.1	1.0 (0.8%)	142.3	1.1 (0.8%)	118.1	0.2 (0.2%)	136.7	-0.8 (-0.6%)
January	141.4	0.4 (0.3%)	165.9	1.0 (0.6%)	129.5	-0.9 (-0.7%)	151.2	-2.3 (-1.5%)
February	123.6	0.1 (0.1%)	159.4	1.2 (0.7%)	113.7	-0.3 (-0.2%)	148.2	-0.3 (-0.2%)
March	106.9	-0.2 (-0.2%)	157.9	0.5 (0.3%)	97.1	0.1 (0.1%)	146.9	0.2 (0.2%)
April	84.0	0.1 (0.1%)	123.4	0.3 (0.3%)	68.6	0.1 (0.2%)	108.4	0.3 (0.3%)
May	75.3	0.0 (0.0%)	106.4	0.1 (0.1%)	66.0	0.1 (0.1%)	97.7	0.2 (0.2%)
June	66.4	0.0 (-0.1%)	81.4	0.1 (0.1%)	60.8	0.1 (0.1%)	75.6	0.3 (0.4%)
July	60.8	0.0 (0.0%)	83.1	-0.1 (-0.1%)	58.8	0.1 (0.1%)	82.1	0.0 (0.0%)
August	82.2	0.0 (0.0%)	121.9	-0.3 (-0.2%)	80.6	0.2 (0.2%)	121.2	0.3 (0.3%)
September	109.5	0.3 (0.3%)	145.0	0.6 (0.4%)	107.5	0.3 (0.3%)	141.7	0.7 (0.5%)

*Source: Version 8.0.6, DSM2 Existing and Future simulations (Node CHCDMC006) converted to chlorides using the equation EC*0.273-43.9)*

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
EC = electrical conductivity
mg/L = milligrams per liter

Table 7-102. Simulated Number of Days by Month of Exceedence of the Chloride Standard for the Delta-Mendota Canal at the Jones Pumping Plant Under Baseline Conditions and CP3

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition	CP3 Change	Existing Condition	CP3 Change	No-Action Alternative	CP3 Change	No-Action Alternative	CP3 Change
	(Number of days)	(Number of days (%))	(Number of days)	(Number of days (%))	(Number of days)	(Number of days (%))	(Number of days)	(Number of days (%))
October	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
November	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
December	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
January	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
February	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
March	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
April	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
May	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
June	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
July	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
August	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
September	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
Total	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node CHCDMC006)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.
Percentage values reported in parenthesis are reported as zero if the change is less than one day.

Key:
% = percent
CP = Comprehensive Plan

Table 7-103. Simulated Monthly Average Salinity and Percent Change for the Delta-Mendota Canal at the Jones Pumping Plant Under Baseline Conditions and CP3

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	CP3 Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	CP3 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP3 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP3 Change (mmhos/cm (%))
October	0.6	0.0 (0.1%)	0.6	0.0 (0.1%)	0.5	0.0 (-0.1%)	0.6	0.0 (-0.4%)
November	0.5	0.0 (-0.1%)	0.6	0.0 (0.1%)	0.5	0.0 (0.0%)	0.6	0.0 (-0.5%)
December	0.6	0.0 (0.6%)	0.7	0.0 (0.6%)	0.6	0.0 (0.1%)	0.7	0.0 (-0.5%)
January	0.7	0.0 (0.2%)	0.8	0.0 (0.5%)	0.6	0.0 (-0.5%)	0.7	0.0 (-1.2%)
February	0.6	0.0 (0.1%)	0.7	0.0 (0.6%)	0.6	0.0 (-0.2%)	0.7	0.0 (-0.2%)
March	0.6	0.0 (-0.2%)	0.7	0.0 (0.3%)	0.5	0.0 (0.1%)	0.7	0.0 (0.1%)
April	0.5	0.0 (0.1%)	0.6	0.0 (0.2%)	0.4	0.0 (0.1%)	0.6	0.0 (0.2%)
May	0.4	0.0 (0.0%)	0.6	0.0 (0.1%)	0.4	0.0 (0.1%)	0.5	0.0 (0.1%)
June	0.4	0.0 (0.0%)	0.5	0.0 (0.1%)	0.4	0.0 (0.1%)	0.4	0.0 (0.3%)
July	0.4	0.0 (0.0%)	0.5	0.0 (-0.1%)	0.4	0.0 (0.1%)	0.5	0.0 (0.0%)
August	0.5	0.0 (0.0%)	0.6	0.0 (-0.2%)	0.5	0.0 (0.1%)	0.6	0.0 (0.2%)
September	0.6	0.0 (0.2%)	0.7	0.0 (0.3%)	0.6	0.0 (0.2%)	0.7	0.0 (0.4%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node CHCDMC006)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
mmhos/cm = millimhos per centimeter

Table 7-104. Simulated Number of Months of Exceedence of the Salinity Standard for the Delta-Mendota Canal at the Jones Pumping Plant Under Baseline Conditions and CP3

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition	CP3 Change	Existing Condition	CP3 Change	No-Action Alternative	CP3 Change	No-Action Alternative	CP3 Change
	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))
October	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
November	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
December	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
January	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
April	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
May	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
June	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
July	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
August	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node CHCDMC006)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan

Impact WQ-19f (CP3): Delta Water Quality in the West Canal at the Mouth of the Clifton Court Forebay Impact WQ-19f (CP3) would be similar to Impact WQ-19f (CP1). The 250-mg/L chloride concentration standard at the West Canal would not be exceeded on an average annual or dry and critical year basis under CP3. CP3 would also not exceed EC thresholds. This impact would be less than significant.

Table 7-105 shows that maximum chloride concentrations under both existing and future project conditions are lower for CP3 than the 250 mg/L threshold. Maximum changes under both existing and future projection conditions are less than 1.5 percent. As shown in Table 7-106, CP2 the maximum change in EC values under existing and future project conditions would be less than 1.5 percent.

Table 7-105. Simulated Monthly Average Chlorides and Percent Change for West Canal at Clifton Court Forebay Under Baseline Conditions and CP3

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mg/L)	CP3 Change (mg/L (%))	Existing Condition (mg/L)	CP3 Change (mg/L (%))	No-Action Alternative (mg/L)	CP3 Change (mg/L (%))	No-Action Alternative (mg/L)	CP3 Change (mg/L (%))
October	110.8	0.3 (0.3%)	124.3	0.4 (0.3%)	110.4	0.0 (0.0%)	125.1	-0.4 (-0.4%)
November	107.2	0.2 (0.2%)	123.4	0.4 (0.3%)	105.7	0.5 (0.5%)	124.8	-0.4 (-0.3%)
December	109.2	1.5 (1.4%)	131.8	1.6 (1.2%)	107.0	0.3 (0.3%)	131.1	-1.4 (-1.1%)
January	128.1	0.7 (0.6%)	154.3	1.5 (0.9%)	120.5	-1.3 (-1.1%)	145.3	-3.6 (-2.5%)
February	107.5	-0.1 (-0.1%)	134.7	1.1 (0.8%)	99.2	-0.2 (-0.2%)	124.2	0.1 (0.1%)
March	91.9	-0.1 (-0.2%)	132.1	1.3 (1.0%)	83.6	0.3 (0.4%)	122.4	0.9 (0.7%)
April	75.6	0.1 (0.2%)	110.3	0.6 (0.5%)	60.8	0.2 (0.4%)	96.4	0.7 (0.7%)
May	70.8	0.1 (0.1%)	99.9	0.2 (0.2%)	61.6	0.2 (0.3%)	91.6	0.5 (0.5%)
June	56.4	0.0 (-0.1%)	73.4	0.1 (0.1%)	51.8	0.0 (0.0%)	68.6	0.2 (0.3%)
July	52.2	0.0 (0.0%)	82.6	-0.1 (-0.2%)	51.3	0.0 (0.1%)	82.3	0.0 (0.0%)
August	80.5	-0.1 (-0.1%)	128.2	-0.3 (-0.2%)	80.4	0.3 (0.4%)	127.5	0.7 (0.5%)
September	115.0	0.5 (0.4%)	157.5	0.7 (0.5%)	114.9	0.6 (0.5%)	154.7	1.0 (0.6%)

*Source: Version 8.0.6, DSM2 Existing and Future simulations (Node CHSWP003) converted to chlorides using the equation EC*0.273-43.9)*

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
EC = electrical conductivity
mg/L = milligrams per liter

Table 7-106. Simulated Monthly Average Salinity and Percent Change for the West Canal at the Clifton Court Forebay Under Baseline Conditions and CP3

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	CP3 Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	CP3 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP3 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP3 Change (mmhos/cm (%))
October	0.6	0.0 (0.2%)	0.6	0.0 (0.2%)	0.6	0.0 (0.0%)	0.6	0.0 (-0.3%)
November	0.6	0.0 (0.2%)	0.6	0.0 (0.3%)	0.5	0.0 (0.4%)	0.6	0.0 (-0.2%)
December	0.6	0.0 (1.0%)	0.6	0.0 (0.9%)	0.6	0.0 (0.2%)	0.6	0.0 (-0.8%)
January	0.6	0.0 (0.4%)	0.7	0.0 (0.7%)	0.6	0.0 (-0.8%)	0.7	0.0 (-1.9%)
February	0.6	0.0 (-0.1%)	0.7	0.0 (0.6%)	0.5	0.0 (-0.1%)	0.6	0.0 (0.0%)
March	0.5	0.0 (-0.1%)	0.6	0.0 (0.7%)	0.5	0.0 (0.2%)	0.6	0.0 (0.5%)
April	0.4	0.0 (0.1%)	0.6	0.0 (0.4%)	0.4	0.0 (0.2%)	0.5	0.0 (0.5%)
May	0.4	0.0 (0.1%)	0.5	0.0 (0.1%)	0.4	0.0 (0.2%)	0.5	0.0 (0.3%)
June	0.4	0.0 (0.0%)	0.4	0.0 (0.1%)	0.4	0.0 (0.0%)	0.4	0.0 (0.2%)
July	0.4	0.0 (0.0%)	0.5	0.0 (-0.1%)	0.3	0.0 (0.0%)	0.5	0.0 (0.0%)
August	0.5	0.0 (0.0%)	0.6	0.0 (-0.2%)	0.5	0.0 (0.2%)	0.6	0.0 (0.4%)
September	0.6	0.0 (0.3%)	0.7	0.0 (0.4%)	0.6	0.0 (0.3%)	0.7	0.0 (0.5%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node CHSWP003)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
mmhos/cm = millimhos per centimeter

Table 7-107 shows the average number of days simulated chloride values exceeded the standards of 250 mg/L for the West Canal at the Clifton Court Forebay in a year. There would be no additional violations throughout the year under both existing and future project conditions. CP3 would not change the baseline compliance levels under both existing and future conditions.

As shown in Table 7-108, CP3 would not result in any additional violations of the salinity standards. CP3 would actually result in decreases in EC during several months of the year. CP3 would not change the baseline compliance levels under both existing and future conditions.

Overall, the impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-107. Simulated Number of Days by Month of Exceedence of the Chloride Standard for the West Canal at the Clifton Court Forebay Under Baseline Conditions and CP3

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition	CP3 Change	Existing Condition	CP3 Change	No-Action Alternative	CP3 Change	No-Action Alternative	CP3 Change
	(Number of days)	(Number of days (%))	(Number of days)	(Number of days (%))	(Number of days)	(Number of days (%))	(Number of days)	(Number of days (%))
October	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
November	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
December	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
January	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
February	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
March	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
April	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
May	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
June	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
July	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
August	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
September	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
Total	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node CHSWP003)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.
Percentage values reported in parenthesis are reported as zero if the change is less than one day.

Key:
% = percent
CP = Comprehensive Plan

Table 7-108. Simulated Number of Months of Exceedence of the Salinity Standard for the West Canal at the Clifton Court Forebay Under Baseline Conditions and CP3

Month	Existing Condition (2005)				Future Condition (2030)			
			Dry and Critical Years		Total All Years		Dry and Critical Years	
		CP3 Change	Existing Condition	CP3 Change	No-Action Alternative	CP3 Change	No-Action Alternative	CP3 Change
		(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))
October	0	0.0 (0.0%)	0	0.0 (0.0%)	1	0.0 (0.0%)	0	0.0 (0.0%)
November	0	0.0 (0.0%)	0	0.0 (0.0%)	3	-1.0 (-33.3%)	2	0.0 (0.0%)
December	0	1.0 (0.0%)	0	1.0 (0.0%)	2	-1.0 (-50.0%)	1	0.0 (0.0%)
January	1	0.0 (0.0%)	1	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
April	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
May	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
June	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
July	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
August	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node CHSWP003)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan

Impact WQ-19g (CP3): Delta Salinity on the San Joaquin River at Vernalis
This impact would be similar to Impact WQ-19g (CP1). On an average monthly basis, EC would meet requirements in all months in both average years and in dry and critical years. CP3 would not exceed EC thresholds on the San Joaquin River at Vernalis, as shown in Tables 7-109 and 7-110. CP3 would not change the baseline compliance levels under both existing and future conditions. The impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-109. Simulated Monthly Average Salinity and Percent Change for the San Joaquin River at Vernalis Under Baseline Conditions and CP3

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	CP3 Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	CP3 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP3 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP3 Change (mmhos/cm (%))
October	0.5	0.0 (0.0%)	0.5	0.0 (0.0%)	0.5	0.0 (0.0%)	0.5	0.0 (0.0%)
November	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)
December	0.8	0.0 (0.0%)	0.8	0.0 (0.0%)	0.7	0.0 (0.0%)	0.8	0.0 (0.0%)
January	0.8	0.0 (0.0%)	0.9	0.0 (0.0%)	0.7	0.0 (0.0%)	0.8	0.0 (0.0%)
February	0.7	0.0 (0.0%)	0.9	0.0 (0.0%)	0.7	0.0 (0.0%)	0.9	0.0 (0.0%)
March	0.6	0.0 (0.0%)	0.9	0.0 (0.0%)	0.6	0.0 (0.0%)	0.8	0.0 (0.0%)
April	0.4	0.0 (0.0%)	0.6	0.0 (0.0%)	0.4	0.0 (0.0%)	0.5	0.0 (0.0%)
May	0.4	0.0 (0.0%)	0.5	0.0 (0.0%)	0.4	0.0 (0.0%)	0.5	0.0 (0.0%)
June	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)
July	0.6	0.0 (0.0%)	0.7	0.0 (0.0%)	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)
August	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)
September	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAN112)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
mmhos/cm = millimhos per centimeter

Table 7-110. Simulated Number of Months of Exceedence of the Salinity Standard for the San Joaquin River at Vernalis Under Baseline Conditions and CP3

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition	CP3 Change	Existing Condition	CP3 Change	No-Action Alternative	CP3 Change	No-Action Alternative	CP3 Change
	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))
October	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
November	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
December	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
January	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
April	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
May	1	0.0 (0.0%)	1	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
June	1	0.0 (0.0%)	1	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
July	1	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)
August	3	0.0 (0.0%)	3	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAN112)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan

Impact WQ-19h (CP3): Delta Salinity on the San Joaquin River at Brandt Bridge This impact would be similar to Impact WQ-19h (CP1). On an average monthly basis, EC would meet requirements in all months in both average years and in dry and critical years, as shown in Table 7-111. CP3 would not measurably change EC on the San Joaquin River at Brandt Bridge. This impact would be less than significant.

Table 7-112 shows the number of months simulated EC values exceeded the standards for the San Joaquin River at Brandt Bridge in the period of simulation. CP3 would not change the existing compliance level for salinity standards for the San Joaquin River at Brandt Bridge. The impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-111. Simulated Monthly Average Salinity and Percent Change for the San Joaquin River at Brandt Bridge Under Baseline Conditions and CP3

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	CP3 Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	CP3 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP3 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP3 Change (mmhos/cm (%))
October	0.5	0.0 (0.0%)	0.5	0.0 (0.0%)	0.5	0.0 (0.0%)	0.5	0.0 (0.0%)
November	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)
December	0.8	0.0 (0.0%)	0.8	0.0 (0.0%)	0.7	0.0 (0.0%)	0.8	0.0 (0.0%)
January	0.8	0.0 (0.0%)	0.9	0.0 (0.0%)	0.7	0.0 (0.0%)	0.8	0.0 (0.0%)
February	0.7	0.0 (0.0%)	0.9	0.0 (0.0%)	0.7	0.0 (0.0%)	0.9	0.0 (0.0%)
March	0.6	0.0 (0.0%)	0.9	0.0 (0.0%)	0.6	0.0 (0.0%)	0.8	0.0 (0.0%)
April	0.4	0.0 (0.0%)	0.6	0.0 (0.0%)	0.4	0.0 (0.0%)	0.5	0.0 (0.0%)
May	0.4	0.0 (0.0%)	0.6	0.0 (0.0%)	0.4	0.0 (0.0%)	0.5	0.0 (0.0%)
June	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)
July	0.6	0.0 (0.0%)	0.7	0.0 (0.0%)	0.6	0.0 (0.0%)	0.7	0.0 (0.0%)
August	0.6	0.0 (0.0%)	0.6	0.0 (0.1%)	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)
September	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAN112)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
mmhos/cm = millimhos per centimeter

Table 7-112. Simulated Number of Months of Exceedence of the Salinity Standard for the San Joaquin River at Brandt Bridge Under Baseline Conditions and CP3

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition	CP3 Change	Existing Condition	CP3 Change	No-Action Alternative	CP3 Change	No-Action Alternative	CP3 Change
	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))
October	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
November	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
December	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
January	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
April	2	0.0 (0.0%)	2	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)
May	1	0.0 (0.0%)	1	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
June	1	0.0 (0.0%)	1	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
July	1	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)
August	2	0.0 (0.0%)	2	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAN112)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan

Impact WQ-19i (CP3): Delta Salinity on the Old River near the Middle River
Impact WQ-19i (CP3) would be similar to Impact WQ-19i (CP1). On an average monthly basis, EC would meet requirements in all months in both average years and in dry and critical years. CP3 would not measurably change EC on the Old River near the Middle River, as shown in Table 7-113. This impact would be less than significant.

Table 7-114 shows the number of months simulated EC values exceeded the standards for the Old River near the Middle River in the period of simulation. Compliance with salinity standards for the Old River near the Middle River would not change under CP3 when compared to the existing conditions. The impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-113. Simulated Monthly Average Salinity and Percent Change for the Old River near the Middle River Under Baseline Conditions and CP3

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	CP3 Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	CP3 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP3 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP3 Change (mmhos/cm (%))
October	0.5	0.0 (0.0%)	0.5	0.0 (0.0%)	0.5	0.0 (0.0%)	0.5	0.0 (0.0%)
November	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)
December	0.8	0.0 (0.0%)	0.8	0.0 (0.0%)	0.7	0.0 (0.0%)	0.8	0.0 (0.0%)
January	0.8	0.0 (0.0%)	0.9	0.0 (0.0%)	0.7	0.0 (0.0%)	0.8	0.0 (0.0%)
February	0.7	0.0 (0.0%)	0.9	0.0 (0.0%)	0.7	0.0 (0.0%)	0.9	0.0 (0.0%)
March	0.6	0.0 (0.0%)	0.9	0.0 (0.0%)	0.6	0.0 (0.0%)	0.8	0.0 (0.0%)
April	0.4	0.0 (0.0%)	0.6	0.0 (0.0%)	0.4	0.0 (0.0%)	0.5	0.0 (0.0%)
May	0.4	0.0 (0.0%)	0.6	0.0 (0.0%)	0.4	0.0 (0.0%)	0.5	0.0 (0.0%)
June	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)
July	0.6	0.0 (0.0%)	0.7	0.0 (0.0%)	0.6	0.0 (0.0%)	0.7	0.0 (0.0%)
August	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)
September	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RMID041)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
mmhos/cm = millimhos per centimeter

Table 7-114. Simulated Number of Months of Exceedence of the Salinity Standard for the Old River near the Middle River Under Baseline Conditions and CP3

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition	CP3 Change	Existing Condition	CP3 Change	No-Action Alternative	CP3 Change	No-Action Alternative	CP3 Change
	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))
October	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
November	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
December	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
January	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
April	2	0.0 (0.0%)	2	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)
May	1	0.0 (0.0%)	1	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
June	1	0.0 (0.0%)	1	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
July	1	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)
August	2	0.0 (0.0%)	2	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RMID041)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan

Impact WQ-19j (CP3): Delta Salinity on the Old River at Tracy Road Bridge
Impact WQ-19j (CP3) would be similar to Impact WQ-19j (CP1). On an average monthly basis, EC would meet requirements in all months in both average years and in dry and critical years. CP3 would not measurably change EC on the Old River at Tracy Road Bridge, as shown in Table 7-115. This impact would be less than significant.

Table 7-116 shows the number of months simulated EC values exceeded the standards for the Old River near Tracy Road Bridge in the period of simulation. Although salinity level would be alternately exceeded and improved during several months, on an annual average basis, the compliance of salinity standards under CP2 would not change from the existing conditions. Overall, CP3 would not change the baseline compliance levels under both existing and future conditions. The impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-115. Simulated Monthly Average Salinity and Percent Change for the Old River at Tracy Road Bridge Under Baseline Conditions and CP3

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	CP3 Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	CP3 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP3 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP3 Change (mmhos/cm (%))
October	0.5	0.0 (0.0%)	0.6	0.0 (-0.1%)	0.5	0.0 (0.1%)	0.5	0.0 (0.0%)
November	0.6	0.0 (0.1%)	0.6	0.0 (0.0%)	0.6	0.0 (0.1%)	0.6	0.0 (0.0%)
December	0.8	0.0 (0.0%)	0.8	0.0 (0.0%)	0.7	0.0 (0.0%)	0.8	0.0 (0.0%)
January	0.8	0.0 (0.0%)	0.9	0.0 (0.0%)	0.7	0.0 (0.0%)	0.8	0.0 (0.0%)
February	0.7	0.0 (0.0%)	0.9	0.0 (0.0%)	0.7	0.0 (0.0%)	0.9	0.0 (0.0%)
March	0.6	0.0 (0.0%)	0.9	0.0 (0.0%)	0.6	0.0 (0.0%)	0.8	0.0 (0.0%)
April	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)	0.4	0.0 (0.0%)	0.6	0.0 (0.0%)
May	0.4	0.0 (0.0%)	0.6	0.0 (0.0%)	0.4	0.0 (0.0%)	0.5	0.0 (0.0%)
June	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)	0.5	0.0 (0.1%)	0.6	0.0 (0.1%)
July	0.6	0.0 (-0.1%)	0.7	0.0 (-0.3%)	0.6	0.0 (0.1%)	0.6	0.0 (0.2%)
August	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.6	0.0 (0.1%)	0.6	0.0 (0.2%)
September	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.5	0.0 (0.2%)	0.6	0.0 (0.4%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node ROLD059)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
mmhos/cm = millimhos per centimeter

Table 7-116. Simulated Number of Months of Exceedence of the Salinity Standard for the Old River at Tracy Road Bridge Under Baseline Conditions and CP3

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition	CP3 Change	Existing Condition	CP3 Change	No-Action Alternative	CP3 Change	No-Action Alternative	CP3 Change
	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))
October	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
November	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
December	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
January	1	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
April	7	0.0 (0.0%)	7	0.0 (0.0%)	5	0.0 (0.0%)	5	0.0 (0.0%)
May	1	0.0 (0.0%)	1	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
June	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
July	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
August	4	0.0 (0.0%)	4	0.0 (0.0%)	3	1.0 (33.3%)	3	1.0 (33.3%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node ROLD059)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan

Impact WQ-20 (CP3): X2 Position CP3 would not change average monthly X2 in either average years or in dry and critical years by more than 0.1 km under either the existing condition or future condition. Although several months may be out of compliance individually under the bases of comparison, the impact would be would be less than significant.

This impact would be similar to Impact WQ-20 (CP1). Table 7-117 shows the simulated monthly average X2 position for CP3 compared to the existing condition and future condition baselines. CalSim-II calculates the X2 position on a 1-month delay; the values shown have been corrected to accurately reflect the X2 position for the specified month. The impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-117. Simulated Monthly Average X2 Position Under Baseline Conditions and CP3

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (km)	CP3 Change (km (%))	Existing Condition (km)	CP3 Change (km (%))	No-Action Alternative (km)	CP3 Change (km (%))	No-Action Alternative (km)	CP3 Change (km (%))
October	83.9	0.0 (0.0%)	86.6	0.0 (0.0%)	83.9	0.0 (0.0%)	86.5	0.0 (0.0%)
November	82.2	0.1 (0.1%)	86.5	0.0 (0.0%)	82.2	0.1 (0.1%)	86.6	0.0 (0.0%)
December	76.1	0.1 (0.1%)	84.8	0.0 (0.0%)	76.0	0.0 (0.0%)	84.7	-0.2 (-0.3%)
January	67.5	0.0 (0.1%)	79.6	0.1 (0.1%)	67.3	0.0 (0.0%)	79.2	0.0 (-0.1%)
February	60.9	0.0 (0.0%)	72.5	0.1 (0.1%)	60.8	0.0 (0.1%)	72.3	0.1 (0.1%)
March	60.9	0.0 (0.0%)	70.3	0.0 (-0.1%)	60.9	0.0 (0.1%)	70.3	0.0 (0.0%)
April	63.5	0.0 (-0.1%)	72.9	-0.1 (-0.1%)	63.4	0.0 (-0.1%)	73.0	-0.1 (-0.1%)
May	67.5	0.0 (0.0%)	77.6	-0.1 (-0.1%)	67.7	-0.1 (-0.1%)	78.0	-0.2 (-0.2%)
June	74.5	0.0 (0.0%)	82.6	-0.1 (-0.1%)	74.7	0.0 (0.0%)	82.8	-0.1 (-0.1%)
July	80.5	0.0 (0.0%)	86.1	0.0 (0.0%)	80.5	0.0 (0.0%)	86.1	0.0 (0.0%)
August	85.6	0.0 (0.0%)	88.8	0.0 (0.0%)	85.6	0.0 (0.0%)	88.6	0.0 (0.0%)
September	82.6	0.0 (0.0%)	91.1	0.0 (0.0%)	82.6	0.0 (0.0%)	90.9	0.0 (0.0%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node X2_PRV)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
km = kilometer
X2 = geographic location of 2 parts per thousand near-bottom salinity isohaline in the Delta, measured in distance upstream from Golden Gate Bridge in Suisun Bay.

CP4 and CP4A – 18.5-Foot Dam Raise, Anadromous Fish Focus with Water Supply Reliability

CP4 and CP4A focus on increasing anadromous fish survival while also increasing water supply reliability. By raising Shasta Dam 18.5 feet, in combination with spillway modifications, CP4 and CP4A would increase the height of the reservoir full pool by 20.5 feet and enlarge the total storage capacity in the reservoir by 634,000 acre-feet. The existing TCD would also be extended to achieve efficient use of the expanded CWP. The additional storage created by the 18.5-foot dam raise would be used to improve the ability to meet temperature objectives and habitat requirements for anadromous fish during drought years and increase water supply reliability. CP4 and CP4A also include the augmentation of spawning gravel and the restoration of riparian, floodplain, and side channel habitat in the upper Sacramento River for fisheries benefit.

CP4A is identical to CP4 except for Shasta Dam and reservoir operations. Both alternatives have similar reservoir operations in that they each dedicate a portion of the new storage in Shasta Lake for fisheries purposes; however, the portion of this dedicated storage varies. For CP4, approximately 378,000 acre-feet of the increased reservoir storage space would be dedicated to increasing the supply of cold water for anadromous fish survival purposes. Operations for the remaining portion of increased storage (approximately 256,000 acre-feet) would be the same as in CP1, with 70,000 acre-feet and 35,000 acre-feet reserved to specifically focus on increasing M&I deliveries during dry and critical years, respectively. For CP4A, approximately 191,000 acre-feet of the increased reservoir storage space would be dedicated to increasing the supply of cold water for anadromous fish survival purposes. Operations for the remaining portion of increased storage (approximately 443,000 acre-feet) would be the same as in CP2 where Shasta Dam operational guidelines would continue essentially unchanged, except during dry years and critical years, when 120,000 acre-feet and 60,000 acre-feet, respectively, of the increased storage capacity in Shasta Reservoir would be reserved for M&I deliveries.

Shasta Lake and Vicinity

Impact WQ-1 (CP4 and CP4A): Temporary Construction-Related Sediment Effects on Shasta Lake and Its Tributaries that Would Violate Water Quality Standards or Adversely Affect Beneficial Uses For CP4 or CP4A, this impact would be similar to Impact WQ-1 (CP3). The nature of inundation and relocation impacts is consistent with those described for CP3 in Chapter 2, “Alternatives.”

The impact for CP4 would be potentially significant. Mitigation for this impact is proposed in Section 7.3.5.

The impact for CP4A would be potentially significant. Mitigation for this impact is proposed in Section 7.3.5.

Impact WQ-2 (CP4 and CP4A): Temporary Construction-Related Temperature Effects on Shasta Lake and Its Tributaries that Would Violate Water Quality Standards or Adversely Affect Beneficial Uses For CP4 or CP4A, this impact would be similar to Impact WQ-2 (CP3). The nature of inundation and relocation impacts is consistent with those described for WQ-2 (CP3).

For CP4, the impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, the impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-3 (CP4 and CP4A): Temporary Construction-Related Metal Effects on Shasta Lake and Its Tributaries that Would Violate Water Quality Standards or Adversely Affect Beneficial Uses For CP4 or CP4A, this impact is similar to WQ-3 (CP1). No construction activities would disturb locations known to contain elevated metal concentrations in either sediments or the water column.

For CP4, the impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, the impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-4 (CP4 and CP4A): Long-Term Sediment Effects that Would Violate Water Quality Standards or Adversely Affect Beneficial Uses in Shasta Lake or Its Tributaries For CP4 or CP4A, this impact would be similar to Impact WQ-4 (CP3). The nature of inundation and relocation impacts is consistent with those described for CP3.

For CP4, the impact would be a potentially significant. Mitigation for this impact is proposed in Section 7.3.5.

For CP4A, the impact would be a potentially significant. Mitigation for this impact is proposed in Section 7.3.5.

Impact WQ-5 (CP4 and CP4A): Long-Term Temperature Effects that Would Violate Water Quality Standards or Adversely Affect Beneficial Uses in Shasta Lake or Its Tributaries For CP4, similar to CP1, this alternative would increase storage on a monthly basis, although it would vary by water year. Table 7-118 illustrates the monthly change in simulated storage for CP4 as a percent increase above the existing condition. On average, CP4 represents an approximately 17-percent increase in the end-of-month storage on an annual basis.

Under CP4, existing water temperature requirements would typically be met in most years; therefore, the additional increase in water storage shown in Table 7-118 would primarily be released for water supply purposes. Accordingly, minimal increases in releases from Shasta Dam would be expected in months when Delta exports are constrained, or when flow is not usable for water supply purposes.

Table 7-118. Simulated Average Increased End-of-Month Shasta Lake Storage – CP4 and CP4A

Month	Existing Conditions (TAF)	CP4 Change (TAF)	CP4 % Increase	CP4A Change (TAF)	CP4 % Increase
October	2,592	526	20.3%	473	18.2%
November	2,568	520	20.2%	462	18.0%
December	2,722	539	19.8%	486	17.9%
January	2,995	545	18.2%	501	16.7%
February	3,267	556	17.0%	517	15.8%
March	3,625	560	15.4%	525	14.5%
April	3,916	555	14.2%	519	13.2%
May	3,941	557	14.1%	521	13.2%
June	3,639	556	15.3%	518	14.2%
July	3,160	548	17.3%	506	16.0%
August	2,834	544	19.2%	503	17.8%
September	2,669	535	20.1%	492	18.4%

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node S4+S44)

Note:
Simulation period: 1922-2003. Change as measured from Existing Condition.

Key:
% = percent
CP = Comprehensive Plan
TAF = thousand acre-feet

Similar to CP1, the increase in storage provided by CP4 fluctuates greatly throughout a year. A key indicator of water temperature benefits of CP4 to the upper Sacramento River between Keswick Dam and Red Bluff is the amount of cold water available in Shasta Lake before the water temperature operation season, about May through October. Similar to CP1, the CWP volume in the lake accumulates during the winter and early spring and is not likely to increase after April. Therefore, the expected increase in spring storage for CP4 should also result in an incremental increase in the CWP volume.

The simulated end-of-April volume of water with a temperature lower than 52˚F for the existing condition and the change in CWP volume for CP4 is shown, by SVI, in Table 7-119.

Table 7-119. Simulated Average Volume of Water Less than 52˚F in Shasta Lake at the End of April – CP4

SVI Year Type	Existing Conditions (TAF)	CP4 Change (TAF)	% Increase	CP4A Change (TAF)	% Increase
Average of All Years	2,609	470	18%	435	17%
Wet	2,916	531	18%	524	18%
Above Normal	2,972	502	17%	465	16%
Below Normal	2,699	462	17%	434	16%
Dry	2,542	441	17%	384	15%
Critical	1,601	364	23%	296	19%

Source: BST (Benchmark Study Team) April 2010 version SRWQM 2005 and 2030 simulations

Notes:
Simulation period: 1922-2003. Change as measured from Existing Condition.
Year types as defined by the Sacramento Valley Index

Key:
˚F = degrees Farenheit
% = percent
CP = Comprehensive Plan
SVI = Sacramento Valley Index
TAF = thousand acre-feet

In addition to illustrating the average change in available CWP, Table 7-119 also shows the influence of climatic conditions on these values. The diversity between water year types, coupled with unique combinations of storage and rainfall, would continue to influence the ability to manage storage in Shasta Lake to maximize carryover capacity. Although a meaningful increase in active storage and carryover storage of the CWP would occur, the impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, similar to CP4, this alternative would increase storage on a monthly basis, although it would vary by water year. Table 7-118 illustrates the monthly change in simulated storage for CP4A as a percent increase above the existing condition. On average, CP4A represents an approximately 16-percent increase in the end-of-month storage on an annual basis.

Under CP4A, existing water temperature requirements would typically be met in most years; therefore, the additional increase in water storage shown in Table 7-118 would primarily be released for water supply purposes. Accordingly, minimal increases in releases from Shasta Dam would be expected in months when Delta exports are constrained, or when flow is not usable for water supply purposes.

Similar to CP4, the increase in storage provided by CP4A fluctuates greatly throughout a year. A key indicator of water temperature benefits of CP4A to the upper Sacramento River between Keswick Dam and Red Bluff is the amount of cold water available in Shasta Lake before the water temperature operation season, about May through October. Similar to CP4, the CWP volume in the lake accumulates during the winter and early spring and is not likely to increase after April. Therefore, the expected increase in spring storage for CP4A should also result in an incremental increase in the CWP volume.

The simulated end-of-April volume of water with a temperature lower than 52°F for the existing condition and the change in CWP volume for CP4A is shown, by SVI year type, in Table 7-119.

In addition to illustrating the average change in available CWP, Table 7-119 also shows the influence of climatic conditions on these values. The diversity between water year types, coupled with unique combinations of storage and rainfall would continue to influence the ability to manage storage in Shasta Lake to maximize carryover capacity. An increase in active storage and carryover storage of the CWP would occur. However, the impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-6 (CP4 and CP4A): Long-Term Metals Effects that Would Violate Water Quality Standards or Adversely Affect Beneficial Uses in Shasta Lake or Its Tributaries For CP4, this impact is similar to CP1. The nature of inundation impacts is consistent with those described for CP3. The impact would be potentially significant. Mitigation for this impact is proposed in Section 7.3.5.

For CP4A, this impact is similar to CP2. The nature of inundation impacts is consistent with those described for CP3. The impact would be potentially significant. Mitigation for this impact is proposed in Section 7.3.5.

Upper Sacramento River (Shasta Dam to Red Bluff)
Impact WQ-7 (CP4 and CP4A): Temporary Construction-Related Sediment Effects on the Upper Sacramento River that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses Construction would include ground-disturbing activities that could result in soil erosion and sediment effects on the upper Sacramento River. Construction impacts are identical for CP4 and CP4A. This impact would be potentially significant for CP4 or CP4A.

Ground-disturbing activities associated with construction could cause soil erosion and sedimentation of local drainages and eventually the Sacramento River. Construction activities could also discharge waste petroleum products or other construction-related substances that could enter these waterways/facilities in runoff. In addition, transportation, handling, and placement of materials used for gravel augmentation as well as clearing, grubbing, and grading during construction could also adversely affect water quality and temporarily increase turbidity and sedimentation downstream from the gravel augmentation sites. In-water construction work at some gravel augmentation sites could also result in temporary increases in turbidity, downstream sedimentation, and accidental discharge of construction-related substances into the river channel.

In addition, riparian, floodplain, and side channel habitat restoration as part of CP4 or CP4A would involve breaching the levee using an excavator, loader, and compaction equipment, excavation of approximately 15,650 cubic yards of earthen material for off-site disposal, and potential vegetation clearing along 0.8 mile of channel. Invasive aquatic vegetation would be removed as well. Although in-water construction is expected to take place during periods of low flow in the Sacramento River (October to November) to minimize effects on water quality, construction activities related to habitat restoration and vegetation clearing could adversely affect water quality and temporarily increase turbidity and sedimentation downstream, or result in the accidental discharge of construction-related substances into the river channel. In addition, excavated sediments could be contaminated with pesticides and metals. Development and implementation of a SWPPP as part of the environmental commitments described in Chapter 2, "Alternatives," would reduce potential impacts related to pesticides and metals.

For CP4, the impact would be potentially significant. Mitigation for this impact is proposed in Section 7.3.5.

For CP4A, the impact would be potentially significant. Mitigation for this impact is proposed in Section 7.3.5.

Impact WQ-8 (CP4 and CP4A): Temporary Construction-Related Temperature Effects on the Upper Sacramento River that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses Construction activities are not anticipated to result in temperature effects on the upper Sacramento River because changes to water temperature in Shasta Lake and subsequent releases to the Sacramento River would be consistent with typical periodic fluctuations. Construction impacts are identical for both CP4 and CP4A. This impact would be less than significant for CP4 or CP4A.

For CP4, this impact would be similar to Impact WQ-8 (CP1). For the same reasons as described for Impact WQ-8 (CP1), the impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, this impact would be similar to Impact WQ-8 (CP1). For the same reasons as described for Impact WQ-8 (CP1), the impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-9 (CP4 and CP4A): Temporary Construction-Related Metal Effects on the Upper Sacramento River that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses Construction activities are not anticipated to result in water quality effects on the upper Sacramento River related to metals because construction would not disturb locations of known elevated metal concentrations. Construction impacts are identical for both CP4 and CP4A. This impact would be less than significant for CP4 or CP4A.

For CP4, this impact would be similar to Impact WQ-9 (CP1). For the same reasons as described for Impact WQ-9 (CP1), the impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, this impact would be similar to Impact WQ-9 (CP1). For the same reasons as described for Impact WQ-9 (CP1), the impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-10 (CP4 and CP4A): Long-Term Sediment Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Upper Sacramento River For CP4, this impact would be similar to Impact WQ-10 (CP1) because the extent of the effect of CP4 on sediment would be similar to that for CP1. For the same reasons as described for Impact WQ-10 (CP1), the impact would be less than significant.

No long-term water quality impacts are anticipated in the upper Sacramento River in regard to sediment because modeling results have indicated that CP4 would cause little change in average mean monthly flow, and could cause a decrease in peak flows that are associated with increased sediment transport. For CP4, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, this impact would be similar to Impact WQ-10 (CP2), which would be similar to, but slightly greater than that for CP1 (i.e., CP2 would have greater potential to reduce erosional processes and sediment transport in the upper Sacramento River). For the same reasons as described for Impact WQ-10 (CP1), this impact would be less than significant.

No long-term water quality impacts are anticipated in the upper Sacramento River in regard to sediment because modeling results have indicated that CP4A would cause little change in average mean monthly winter flows during some years, which could slightly reduce sediment transport. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-11 (CP4 and CP4A): Long-Term Temperature Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Upper Sacramento River Analysis of temperature modeling results indicates that CP4 and CP4A would improve compliance with the temperature requirements on the Sacramento River because of the increased depth of the CWP in Shasta Lake and the associated enhanced ability to regulate water temperature releases to the upper Sacramento River. Therefore, the impact on water quality measured as temperature would be beneficial.

CP4 and CP4A would increase the ability of Shasta Dam to release cold water and regulate water temperature in the upper Sacramento River, primarily in dry and critical years. Raising Shasta Dam 18.5 feet would increase the CWP and benefit seasonal water temperatures along the upper Sacramento River. This section focuses on compliance with water quality standards for temperature. For an analysis of temperature effects on fisheries and aquatic habitat, see Chapter 11, "Fisheries and Aquatic Resources."

Analysis of temperature modeling results indicates that CP4 would have a beneficial effect on temperature within the upper Sacramento River with a measurable decrease in average monthly water temperature during summer months under both existing and future conditions. For instance, at the Balls Ferry compliance station in September, average monthly water temperature would be reduced by 1.4°F under CP4 for both existing and future conditions. During October at Balls Ferry, the average monthly temperature would decrease by 1.6°F under CP4 for both existing and future conditions. For more information on modeling results and monthly water temperature, see Chapter 11, "Fisheries and Aquatic Resources."

Decreased temperatures would improve compliance with the temperature objectives for the upper Sacramento River in the 2009 NMFS BO. Analysis of modeling results indicates that CP4 would reduce temperature exceedences at Balls Ferry by 29 percent under existing conditions and 32 percent under future conditions. At the Bend Bridge compliance station, CP4 would reduce temperature exceedences by 13-percent under existing conditions and 13 percent under future conditions. Table 7-38 summarizes the temperature modeling results.

The impact of CP4 would be beneficial; CP4 would have the greatest beneficial effect on water temperature of all alternatives evaluated. Mitigation for this impact is not needed, and thus not proposed.

Analysis of temperature modeling results indicates that CP4A would have a beneficial effect on temperature within the upper Sacramento River with a measurable decrease in average monthly water temperature during summer months under both existing and future conditions. For instance, at the Balls Ferry compliance station in September, average monthly water temperature would be reduced by 1.2°F under CP4A for both existing and future conditions. During October at Balls Ferry, the average monthly temperature would decrease by 1.4°F under CP4A for both existing and future conditions. For more information on modeling results and monthly water temperature, see Chapter 11, "Fisheries and Aquatic Resources."

Decreased temperatures would improve compliance with the temperature objectives for the upper Sacramento River in the 2009 NMFS BO. Analysis of modeling results indicates that CP4A would reduce temperature exceedences at Balls Ferry by 25 percent under existing conditions and 25 percent under future conditions. At the Bend Bridge compliance station, CP4A would reduce temperature exceedences by 11 percent under existing conditions and 11 percent under future conditions. Table 7-38 summarizes the temperature modeling results.

The impact of CP4A would be beneficial; CP4A would be only slightly less beneficial than CP4, which has the greatest beneficial effect on water temperature of all alternatives evaluated. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-12 (CP4 and CP4A): Long-Term Metals Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Upper Sacramento River Long-term operation of the project could result in water quality effects on the upper Sacramento River in regard to metals as a result of erosional processes to historic mining and smelting operation features. This impact would be potentially significant for CP4 or CP4A.

For CP4, this impact is similar to Impact WQ-12 (CP1) because the extent of the effect of CP4 on metals would be similar to that for CP1. For the same reasons as described for Impact WQ-12 (CP1), the impact would be potentially significant for CP4. Mitigation for this impact is proposed in Section 7.3.5.

For CP4A, this impact would be similar to Impact WQ-12 (CP2) because the extent of the effect of CP4A on metals would be similar to but slightly greater than that for CP1. For the same reasons as described for CP2, this impact would be potentially significant for CP4A. Mitigation for this impact is proposed in Section 7.3.5.

Lower Sacramento River and Delta and CVP/SWP Service Areas

Impact WQ-13 (CP4 and CP4A): Temporary Construction-Related Sediment Effects on the Extended Study Area that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses Construction of CP4 or CP4A is not anticipated to affect water quality conditions in the extended study area. Construction impacts are identical for CP4 and CP4A. This impact would be less than significant for CP4 or CP4A.

For CP4, this impact would be similar to Impact WQ-13 (CP1). For the same reasons as described for Impact WQ-13 (CP1), the impact would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, this impact would be similar to Impact WQ-13 (CP1). For the same reasons as described for Impact WQ-13 (CP1), the impact would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-14 (CP4 and CP4A): Temporary Construction-Related Temperature Effects on the Extended Study Area that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses This impact for CP4 or CP4A would be similar to Impact WQ-14 (CP1). For the same reasons as described for Impact WQ-14 (CP1), the impact would be less than significant for CP4 or CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-15 (CP4 and CP4A): Temporary Construction-Related Metal Effects on the Extended Study Area that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses This impact for CP4 or CP4A would be similar to Impact WQ-15 (CP1). For the same reasons as described for Impact WQ-15 (CP1), the impact would be less than significant for CP4 or CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-16 (CP4 and CP4A): Long-Term Sediment Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Extended Study Area Project implementation could affect water quality in the extended study area, but effects would diminish with distance. This impact would be less than significant for CP4 or CP4A.

For CP4, this impact would be similar to Impact WQ-16 (CP1). For the same reasons described for Impact WQ-16 (CP1), the impact would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, this impact would be similar to Impact WQ-16 (CP1). For the same reasons described for Impact WQ-16 (CP1), the impact would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-17 (CP4 and CP4A): Long-Term Temperature Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Extended Study Area For CP4, this impact would be similar to Impact WQ-17 (CP1). Analysis of temperature modeling shows little to no change in temperature at RBPP caused by CP4. This suggests that there would be no changes in temperature beyond RBPP as a result of CP4. The impact would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, this impact would be similar to Impact WQ-17 (CP1). Analysis of temperature modeling shows little to no change in temperature at RBPP caused by CP4A. This suggests that there would be no changes in temperature beyond RBPP as a result of CP4A. This impact would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-18 (CP4 and CP4A): Long-Term Metals Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Extended Study Area This impact for CP4 or CP4A would be similar to Impact WQ-18 (CP1). For the same reasons described for Impact WQ-18

(CP1), the impact would be potentially significant for CP4 or CP4A. Mitigation for this impact is proposed in Section 7.3.5.

Impact WQ-19a (CP4 and CP4A): Delta Salinity on the Sacramento River at Collinsville This impact would be the same as Impact WQ-19a (CP1) for CP4. Operations for CP4 would result in both increases and decreases in salinity; however, none of the increases would be sufficient to change compliance for the Sacramento River at Collinsville. On a percentage basis, all increases in salinity would be less than 5 percent. The operation of CP4 would not result in any violations of the salinity standards for the Sacramento River at Collinsville under both existing and future conditions. The impact would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, this impact would be similar to Impact WQ-19a (CP2). Operations for CP4A would result in both increases and decreases in salinity; however, none of the increases would be sufficient to change compliance for the Sacramento River at Collinsville. On a percentage basis, all increases in salinity would be less than 5 percent. The operation of CP4A would not result in any violation of the salinity standards under both existing and future conditions. This impact would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-19b (CP4 and CP4A): Delta Salinity on the Sacramento River at Jersey Point This impact would be the same as Impact WQ-19b (CP1) for CP4. On an average monthly basis, EC would meet the requirements in all months in an average year. On a percentage basis, all increases in salinity would be less than 5 percent. Furthermore, all changes during April through August would be less than 2 percent. Overall, the frequency of exceedence of salinity standards for the San Joaquin River at Jersey Point under CP4 would be similar to those under existing and future conditions. The impact would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, the impact would be similar to Impact WQ-19b (CP2). On an average basis, EC would meet the requirements in in both average years and in dry and critical years. Furthermore, all changes during April through August would be less than 2 percent. CP4A would result in an increase in the frequency of violations under existing conditions during June, by 10 percent in all years and 12.5 percent during dry and critical years. However, the EC standards are not violated on an average monthly basis. Overall, frequency of violation of salinity standards for the San Joaquin River at Jersey Point under CP4A would be similar to those under existing and future conditions. This impact would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-19c (CP4 and CP4A): Delta Salinity on the Sacramento River at Emmaton This impact would be the same as Impact WQ-19c (CP1) for CP4. On an average monthly basis, EC would meet the requirements in all months on an average annual basis. On a percentage basis, all increases in salinity would be less than 5 percent. Operations of CP4 would not result in any additional violation of salinity standards between October and March. CP4 would result in an increase in the frequency of violations under existing and future conditions during May, by up to 100 percent in all years and dry and critical years. However, CP4 would result in a decrease in the frequency of violations under existing and future conditions during August and April, by up to 11.5 percent in all years and up to 50 percent during dry and critical years. The impact would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, the impact would be similar to Impact WQ-19c (CP2). Operations for CP2 would result in both increases and decreases in salinity in comparison to baseline conditions; however, none of the increases would be sufficient to change compliance for the Sacramento River at Emmaton. On a percentage basis, all increases in salinity would be less than 5 percent. On an average monthly basis, EC requirements would be satisfied in all months in an average year under CP4A operations. Maximum change in monthly EC would not be greater than 5 percent under both existing and future conditions. Operations of CP4A would not result in any violation of salinity standards between October and March. CP4A would result in an increase in the frequency of violations under existing and future conditions during May, by up to 100 percent in all years and dry and critical years. However, CP4A would result in a decrease in the frequency of violations under existing and future conditions during August and April, by up to 50 percent in all years and dry and critical years. On an average monthly basis, the standards are not violated. Overall, the compliance of salinity standards for the Sacramento River at Emmaton would be very similar to the baseline levels under both existing and future conditions. This impact would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-19d (CP4 and CP4A): Delta Salinity on the Old River at Rock Slough This impact would be similar to Impact WQ-19d (CP1) for CP4. On an average annual basis, all months except October through January under both the existing condition and future condition would be less than 150 mg/L. In average annual years, CP4 would not increase chlorides by more than 1.1 percent. Maximum change in chloride concentrations under the CP4 are less than 2.1 percent for dry and critical years. The change in chloride concentration would not affect compliance with the standard; it would already be exceeded under the basis of comparison. The impact would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, the impact would be similar to Impact WQ-19d (CP1), and the same as WQ-19d (CP2). On an average annual basis, chloride levels under both the existing condition and future condition would be less than 150 mg/L from February through July. In average annual years, CP4A would not increase chlorides by more than 1.3 percent. For dry and critical years, a maximum change of 2.3 percent in chloride concentration would occur. Change in chloride concentration would not affect compliance with the standard as it would already be exceeded under the basis of comparison. CP4A would result in no daily violations of the chloride standards under both existing and future conditions for CP4A. Overall, CP4A would not alter the compliance level observed under the existing and future conditions. This impact would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-19e (CP4 and CP4A): Delta Salinity on the Delta-Mendota Canal at Jones Pumping Plant The water quality requirement on the Delta-Mendota Canal at Jones Pumping Plant has two components, a chloride requirement and an EC requirement.

For CP4, this impact would be the same as impact WQ-19e (CP1). CP4 would not cause exceedence of chloride thresholds. All increases in chloride concentrations would be less than 5 percent. Chloride values under CP4 would be similar to the baseline values under both existing and future conditions. Increases in EC would be less than 5 percent under CP4 and would not exceed the EC threshold. The impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, the impact would be the same as impact WQ-19e (CP2), which is similar to Impact WQ-19e (CP1). CP4A would not cause exceedence of chloride thresholds. All increases in chloride concentrations would be less than 5 percent. Chloride values under CP4A would be similar to the baseline values under both existing and future conditions. Increases in EC would be less than 5 percent under CP4A and would not exceed the EC threshold. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-19f (CP4 and CP4A): Delta Salinity on the West Canal at Clifton Court Forebay This impact would be the same as WQ-19f (CP1) for CP4. The 250 mg/L chloride concentration standard at the West Canal would not be exceeded on an average annual or dry and critical year basis under CP1. CP4 would also not exceed EC thresholds. This impact would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, this impact would be the same as WQ-19f (CP2). The 250 mg/L chloride concentration standard at the West Canal would not be exceeded on an average annual or dry and critical year basis. CP4A would also not exceed EC thresholds. This impact would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-19g (CP4 and CP4A): Delta Salinity on the San Joaquin River near Vernalis This impact would be the same as Impact WQ-19g (CP1) for CP4, where CP1 would not change the baseline compliance levels under both existing and future conditions. On an average monthly basis, EC would meet requirements in all months in both average years and in dry and critical years. CP4 would not exceed EC thresholds on the San Joaquin River at Vernalis. CP4 would not change the baseline compliance levels under both existing and future conditions. This impact would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, this impact would be similar to Impact WQ-19g (CP2), which is similar to Impact WQ-19g (CP1). On an average monthly basis, EC would meet requirements in all months, in both average years and in dry and critical years. CP4A would not exceed EC thresholds on the San Joaquin River at Vernalis. CP4A would not change the baseline compliance levels under both existing and future conditions. This impact would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-19h (CP4 and CP4A): Delta Salinity on the San Joaquin River at Brandt Bridge This impact would be the same as Impact WQ-19h (CP1) for CP4, where CP1 would not change the existing compliance level under both existing and future project conditions. On an average monthly basis, EC would meet requirements in all months in both average years and in dry and critical years. CP4 would not change EC on the San Joaquin River at Brandt Bridge. The impact would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, this impact would be the same as Impact WQ-19h (CP2), where, on an average monthly basis, EC would meet requirements in all months in both average years and in dry and critical years, and EC would not measurably change on the San Joaquin River at Brandt Bridge. This impact would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-19i (CP4 and CP4A): Delta Salinity on the Old River near the Middle River This impact would be similar to Impact WQ-19i (CP1) for CP4. On an average monthly basis, EC would meet requirements in all months in both average years and in dry and critical years. CP4 would not measurably change EC on the Old River near the Middle River. Compliance with salinity standards for the Old River near the Middle River would not change under CP4. The impact would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

This impact would be similar Impact WQ-19i (CP2), which is similar to Impact WQ-19i (CP1), for CP4A. On an average monthly basis, EC would meet requirements in all months in both average years and in dry and critical years. Compliance with salinity standards for the Old River near the Middle River would not change under CP4A when compared to the existing conditions. CP4A would not measurably change EC on the Old River near the Middle River. This impact would be less than significant CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-19j (CP4 and CP4A): Delta Salinity on the Old River near Tracy Road Bridge This impact would be similar to Impact WQ-19j (CP1) for CP4. On an average monthly basis, EC would meet requirements in all months in both average years and in dry and critical years. CP4 would not measurably change EC on the Old River at Tracy Road Bridge. The impact would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

This impact would be similar to Impact WQ-19j (CP2), which is similar to Impact WQ-19j (CP1), for CP4A. On an average monthly basis, EC would meet requirements in all months in both average years and in dry and critical years. CP4A would not change the baseline compliance levels under both existing and future conditions. CP4A would not measurably change EC on the Old River at Tracy Road Bridge. Therefore, this impact would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-20 (CP4 and CP4A): X2 Position This impact would be the same as WQ-20 (CP1) for CP4. CP4 would not change average monthly X2 in either average years or in dry and critical years by more than 0.1 km under either the existing condition or future condition. Although several months may be out of compliance individually under the bases of comparison, this impact would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

This impact would be the same as WQ-20 (CP2), which would be similar to similar to Impact WQ-20 (CP1), for CP4A. CP4A would not change average monthly X2 in either average years or in dry and critical years by more than 0.1 km under either the existing condition or future condition. Although several months may be out of compliance individually under the bases of comparison, the impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CP5 – 18.5-Foot Dam Raise, Combination Plan

CP5 primarily focuses on increasing water supply reliability, anadromous fish survival, Shasta Lake area environmental resources, and recreation opportunities. By raising Shasta Dam 18.5 feet, in combination with spillway modifications, CP5 would increase the height of the reservoir full pool by 20.5 feet and enlarge the total storage capacity in the reservoir by 634,000 acre-feet. The existing TCD would be extended to achieve efficient use of the expanded CWP. Shasta Dam operational guidelines would continue essentially unchanged, except during dry years and critical years, when 150,000 acre-feet and 75,000 acre-feet, respectively, of the increased storage capacity in Shasta

Reservoir would be reserved to specifically focus on increasing M&I deliveries. CP5 also includes constructing additional fish habitat in and along the shoreline of Shasta Lake and along the lower reaches of its tributaries; augmenting spawning gravel and restoring riparian, floodplain, and side channel habitat in the upper Sacramento River; and increasing recreation opportunities at Shasta Lake.

CP5 would help reduce future water shortages through increasing drought year and average year water supply reliability for agricultural and M&I deliveries. In addition, the increased depth and volume of the CWP in Shasta Reservoir would contribute to improving seasonal water temperatures for anadromous fish in the upper Sacramento River.

Shasta Lake and Vicinity

Impact WQ-1 (CP5): Temporary Construction-Related Sediment Effects on Shasta Lake and Its Tributaries that Would Violate Water Quality Standards or Adversely Affect Beneficial Uses This impact is similar to WQ-1 (CP3). However, CP5 includes several ecosystem restoration projects that would require temporary construction-related activities, as described in Chapter 2, “Alternatives.”

Although the environmental protection measures and BMPs described in Chapter 2, “Alternatives,” are intended to reduce the potential effects of introducing sediment into Shasta Lake and its tributaries, CP5 would affect water quality by increasing the levels of turbidity and suspended sediment in the receiving waters at levels that could be inconsistent with the Basin Plan. These increased levels of turbidity and suspended sediment could affect the beneficial uses of Shasta Lake and/or its tributaries. Therefore, the impact would be potentially significant. Mitigation for this impact is proposed in Section 7.3.5.

Impact WQ-2 (CP5): Temporary Construction-Related Temperature Effects on Shasta Lake and Its Tributaries that Would Violate Water Quality Standards or Adversely Affect Beneficial Uses This impact would be similar to Impact WQ-2 (CP3). The nature of inundation impacts is consistent with those described for CP3. However, relocation activities under CP5 would expose a similar but greater acreage to erosion than would CP3 (up to 3,337 acres). The impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-3 (CP5): Temporary Construction-Related Metal Effects on Shasta Lake and Its Tributaries that Would Violate Water Quality Standards or Adversely Affect Beneficial Uses This impact is similar to WQ-3 (CP1). No construction activities would disturb locations known to contain elevated metal concentrations in either sediments or the water column. Therefore, the impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-4 (CP5): Long-Term Sediment Effects that Would Violate Water Quality Standards or Adversely Affect Beneficial Uses in Shasta Lake or Its Tributaries This impact is similar to WQ-4 (CP3). Although some ecosystem enhancement measures (i.e., road restoration) are expected to reduce the long-term sediment delivery to Shasta Lake and its tributaries, CP5 would nonetheless result in increased levels of suspended sediment and turbidity that could affect beneficial uses. The amount of sediment that could be delivered is not quantifiable because of the size of the lake and the number of variables that influence sediment transport and delivery. The impact would be a potentially significant. Mitigation for this impact is proposed in Section 7.3.5.

Impact WQ-5 (CP5): Long-Term Temperature Effects that Would Violate Water Quality Standards or Adversely Affect Beneficial Uses in Shasta Lake or Its Tributaries Similar to the discussion in CP3, this alternative would increase storage on a monthly basis although it would vary by water year. Table 7-120 illustrates the monthly change in simulated storage for CP5 as a percent increase above the existing condition. On average, CP5 represents an approximately 13 percent increase in the end-of-month storage on an annual basis. This impact would be less than significant.

Table 7-120. Simulated Average End-of-Month Shasta Lake Storage – CP5

Month	Existing Conditions (TAF)	CP5 Change (TAF)	CP5 % Increase
October	2,592	383	14.8%
November	2,568	373	14.5%
December	2,722	409	15.0%
January	2,995	428	14.3%
February	3,267	449	13.7%
March	3,625	460	12.7%
April	3,916	451	11.5%
May	3,941	452	11.5%
June	3,639	447	12.3%
July	3,160	428	13.6%
August	2,834	422	14.9%
September	2,669	404	15.1%

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node S4+S44)
Note:
Simulation period: 1922-2003. Change as measured from Existing Condition.
Key:
% = percent
CP = Comprehensive Plan
TAF = thousand acre-feet

Consistent with the discussion presented under CP3, existing water temperature requirements would typically be met in most years. The simulated end-of-April volume of water with a temperature lower than 52°F for the existing condition and the change in CWP volume for CP5 is shown, by SVI, in Table 7-121.

Table 7-121. Simulated Average Volume of Water Less than 52°F in Shasta Lake at the End of April – CP5

SVI Year Type	Existing Conditions (TAF)	CP5 Change (TAF)	% Increase
Average of All Years	2,609	378	15%
Wet	2,916	520	18%
Above Normal	2,972	439	15%
Below Normal	2,699	357	13%
Dry	2,542	317	12%
Critical	1,601	142	9%

Source: BST (Benchmark Study Team) April 2010 version SRWQM 2005 and 2030 simulations

Notes:
Simulation period: 1922-2003. Change as measured from Existing Condition.
Year types as defined by the Sacramento Valley Index

Key:
°F = degrees Farenheit
% = percent
CP = Comprehensive Plan
SVI = Sacramento Valley Index
TAF = thousand acre-feet

In addition to illustrating the average change in available CWP, Table 7-121 also shows the influence of climatic conditions on these values. The diversity between water year types, coupled with unique combinations of storage and rainfall, would continue to influence the ability to manage storage in Shasta Lake to maximize carryover capacity. Although a meaningful increase in active storage and carryover storage of the CWP would occur, the impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-6 (CP5): Long-Term Metals Effects that Would Violate Water Quality Standards or Adversely Affect Beneficial Uses in Shasta Lake or Its Tributaries This impact is similar to CP1. The nature of inundation impacts is consistent with those described for CP3. The impact would be potentially significant. Mitigation for this impact is proposed in Section 7.3.5.

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact WQ-7 (CP5): Temporary Construction-Related Sediment Effects on the Upper Sacramento River that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses Construction would include ground-disturbing activities that could result in soil erosion and sediment effects on the upper Sacramento River. This impact would be potentially significant.

Ground-disturbing activities associated with construction could cause soil erosion and sedimentation of local drainages and eventually the Sacramento River. Construction activities could also discharge waste petroleum products or other construction-related substances that could enter these waterways/facilities in runoff. As described for Impact WQ-7 (CP4 and CP4A), gravel augmentation construction activities could also adversely affect water quality and temporarily increase turbidity and sedimentation downstream from the gravel augmentation sites.

In addition, riparian, floodplain, and side channel habitat restoration activities as part of CP5 would involve breaching the levee using an excavator, loader, and compaction equipment, excavation of approximately 15,650 cubic yards of earthen material for off-site disposal, and potential vegetation clearing along 0.8 mile of channel. Invasive aquatic vegetation would be removed as well. As described for Impact WQ-7 (CP4 and CP4A), construction activities related to habitat restoration and vegetation clearing could adversely affect water quality and temporarily increase turbidity and sedimentation downstream, or result in the accidental discharge of construction-related substances into the river channel. In addition, excavated sediments could be contaminated with pesticides and metals. Development and implementation of a SWPPP as part of the environmental commitments described in Chapter 2, "Alternatives," would reduce potential impacts related to pesticides and metals. However, the impact would be potentially significant. Mitigation for this impact is proposed in Section 7.3.5.

Impact WQ-8 (CP5): Temporary Construction-Related Temperature Effects on the Upper Sacramento River that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses Construction activities are not anticipated to result in temperature effects on the upper Sacramento River because changes to water temperature in Shasta Lake and subsequent releases to the Sacramento River would be consistent with typical periodic fluctuations. This impact would be less than significant.

This impact would be similar to Impact WQ-8 (CP1). For the same reasons described for Impact WQ-8 (CP1), the impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-9 (CP5): Temporary Construction-Related Metal Effects on the Upper Sacramento River that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses Construction activities are not anticipated to result in water quality effects on the upper Sacramento River related to metals because construction would not disturb locations of known elevated metal concentrations. This impact would be less than significant.

This impact would be similar to Impact WQ-9 (CP1). For the same reasons described for Impact WQ-9 (CP1), the impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-10 (CP5): Long-Term Sediment Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Upper Sacramento River No long-term water quality impacts are anticipated in the upper Sacramento River in regard to sediment because modeling results have indicated that CP5 would cause little change in average mean monthly flow, and could cause a decrease in peak flows that are associated with increased sediment transport. This impact would be less than significant.

This impact would be similar to Impact WQ-10 (CP1) because the extent of the effect of CP5 on sediment would be similar to that for CP1. For the same reasons as described for Impact WQ-10 (CP1), the impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-11 (CP5): Long-Term Temperature Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Upper Sacramento River Analysis of temperature modeling results indicates that CP5 would improve compliance with the temperature requirements on the Sacramento River because of the increased depth of the CWP in Shasta Lake and the associated enhanced ability to regulate water temperature releases to the upper Sacramento River. Therefore, the impact on water quality measured as temperature would be beneficial.

CP5 would increase the ability of Shasta Dam to release cold water and regulate water temperature in the upper Sacramento River, primarily in dry and critical years. Raising Shasta Dam 18.5 feet would increase the CWP and benefit seasonal water temperatures along the upper Sacramento River. This section focuses on compliance with water quality standards for temperature. For an analysis of temperature effects on fisheries and aquatic habitat, see Chapter 11, "Fisheries and Aquatic Resources."

CP5 is the same as CP3 for both flow and temperature characteristics. Therefore, separate temperature modeling was not completed for CP5. See Impact WQ-11 (CP3) for a more complete discussion on temperature modeling analysis. For the same reasons as described for Impact WQ-11 (CP3), the impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-12 (CP5): Long-Term Metals Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Upper Sacramento River Long-term operation of the project could result in water quality effects on the upper Sacramento River in regard to metals as a result of erosional processes to historic mining and smelting operation features. This impact would be potentially significant.

This impact would be similar to Impact WQ-12 (CP1) because the extent of the effect of CP5 on metals would be similar to that for CP1. For the same reasons as described for Impact WQ-12 (CP1), the impact would be potentially significant. Mitigation for this impact is proposed in Section 7.3.5.

Lower Sacramento River and Delta and CVP/SWP Service Areas
Impact WQ-13 (CP5): Temporary Construction-Related Sediment Effects on the Extended Study Area that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses Construction is not anticipated to affect water quality conditions in the extended study area. This impact would be less than significant.

This impact is similar to Impact WQ-13 (CP1). For the same reasons as described for Impact WQ-13 (CP1), the impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-14 (CP5): Temporary Construction-Related Temperature Effects on the Extended Study Area that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses This impact is similar to Impact WQ-14 (CP1). For the same reasons as described for Impact WQ-14 (CP1), the impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-15 (CP5): Temporary Construction-Related Metal Effects on the Extended Study Area that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses This impact is similar to Impact WQ-15 (CP1). For the same reasons as described for Impact WQ-15 (CP1), the impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-16 (CP5): Long-Term Sediment Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Extended Study Area Project implementation could affect water quality in the extended study area, but effects would diminish with distance. This impact would be less than significant.

This impact is similar to Impact WQ-16 (CP1). For the same reasons as described for Impact WQ-16 (CP1), the impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-17 (CP5): Long-Term Temperature Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Extended Study Area This impact is similar to Impact WQ-17 (CP1). Analysis of temperature modeling shows little to no change in temperature at RBPP caused by CP5. This suggests that no changes in temperature would occur beyond RBPP as a result of CP5. The impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact WQ-18 (CP5): Long-Term Metals Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Extended Study Area This impact is similar to Impact WQ-18 (CP1). For the same reasons as described for CP1, the impact would be potentially significant. Mitigation for this impact is proposed in Section 7.3.5.

Impact WQ-19a (CP5): Delta Salinity on the Sacramento River at Collinsville Impact WQ-19a (CP5) would be similar to Impact WQ-19a (CP1). This impact would be less than significant.

As shown in Table 7-122, operations for CP5 result in both increases and decreases in salinity; however, none of the increases would be sufficient to change compliance for the Sacramento River at Collinsville. Similarly, on a percentage basis, all increases in salinity would be less than 1 percent; this would be within the range of natural variability. Table 7-123 shows the number of months simulated EC values exceeded the standards for the Sacramento River at Collinsville in the period of simulation. The operation of CP5 would not result in any violation of the salinity standards under both existing and future conditions. The impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-122. Simulated Monthly Average Salinity and Percent Change for the Sacramento River at Collinsville Under Baseline Conditions and CP5

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	CP5 Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	CP5 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP5 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP5 Change (mmhos/cm (%))
October	6.0	-0.1 (-1.1%)	7.1	-0.1 (-1.0%)	6.0	-0.1 (-1.3%)	7.1	0.0 (0.0%)
November	5.1	0.0 (-0.2%)	6.8	-0.1 (-1.1%)	5.1	0.0 (-0.1%)	6.9	0.0 (0.0%)
December	3.6	0.0 (0.0%)	5.5	0.0 (-0.1%)	3.6	0.0 (-0.4%)	5.5	0.0 (0.0%)
January	1.8	0.0 (-0.1%)	3.4	0.0 (0.2%)	1.7	0.0 (-0.5%)	3.3	0.0 (0.1%)
February	0.8	0.0 (0.4%)	1.7	0.0 (1.2%)	0.8	0.0 (0.2%)	1.6	0.0 (0.0%)
March	0.6	0.0 (-0.1%)	1.2	0.0 (-0.5%)	0.6	0.0 (0.6%)	1.1	0.0 (0.0%)
April	0.7	0.0 (-0.9%)	1.4	0.0 (-1.2%)	0.7	0.0 (-0.8%)	1.5	0.0 (0.0%)
May	1.1	0.0 (-0.9%)	2.3	0.0 (-0.9%)	1.1	0.0 (-1.0%)	2.4	0.0 (0.0%)
June	2.2	0.0 (-0.1%)	4.0	0.0 (-0.2%)	2.2	0.0 (0.4%)	4.1	0.0 (0.0%)
July	3.2	0.0 (-0.2%)	5.3	0.0 (-0.6%)	3.2	0.0 (-0.1%)	5.5	0.0 (0.0%)
August	5.3	0.0 (-0.3%)	7.3	-0.1 (-0.9%)	5.4	0.0 (-0.5%)	7.4	0.0 (0.0%)
September	5.2	-0.1 (-1.0%)	8.8	-0.2 (-1.7%)	5.2	-0.1 (-1.6%)	8.8	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAC081)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
mmhos/cm = millimhos per centimeter

Table 7-123. Simulated Number of Months of Exceedence of the Salinity Standard for the Sacramento River at Collinsville Under Baseline Conditions and CP5

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition	CP5 Change	Existing Condition	CP5 Change	No-Action Alternative	CP5 Change	No-Action Alternative	CP5 Change
	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))
October	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
November	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
December	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
January	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
April	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
May	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
June	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
July	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
August	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAC081)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
mmhos/cm = millimhos per centimeter

Impact WQ-19b (CP5): Delta Salinity on the San Joaquin River at Jersey Point
Impact WQ-19b (CP5) would be similar to Impact WQ-19b (CP1). On an average monthly basis, EC would meet the requirements in all months in an average year. Moreover, CP5 would not increase the EC at Jersey Point. On a percentage basis, all increases in salinity would be less than 5 percent. This impact would be less than significant.

As shown in Table 7-124, the basis of comparison would meet the requirement on an average basis in both average years and in dry and critical years. Furthermore, all changes during April through August would be less than 2 percent. Table 7-125 shows the number of months simulated EC values exceeded the standards for San Joaquin River at Jersey Point in the period of simulation. CP5 would result in an increase in the frequency of violations under future conditions during July, by 2 percent in all years and 4.8 percent during dry and critical years. However, CP5 would result in a decrease in the frequency of violations under future conditions during August, by 1.3 percent in all years and 3.7 percent during dry and critical years. The impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-124. Simulated Monthly Average Salinity and Percent Change for the San Joaquin River at Jersey Point Under Baseline Conditions and CP5

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	CP5 Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	CP5 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP5 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP5 Change (mmhos/cm (%))
October	1.6	0.0 (-0.5%)	1.8	0.0 (-1.2%)	1.6	0.0 (-0.7%)	1.9	0.0 (0.0%)
November	1.5	0.0 (1.3%)	1.8	0.0 (0.3%)	1.5	0.0 (1.7%)	1.8	0.0 (0.0%)
December	1.2	0.0 (0.9%)	1.8	0.0 (0.3%)	1.2	0.0 (0.5%)	1.7	0.0 (0.0%)
January	0.7	0.0 (0.2%)	1.1	0.0 (0.7%)	0.7	0.0 (0.6%)	1.0	0.0 (0.1%)
February	0.3	0.0 (1.2%)	0.5	0.0 (2.5%)	0.3	0.0 (2.1%)	0.5	0.0 (0.0%)
March	0.3	0.0 (0.2%)	0.3	0.0 (0.6%)	0.3	0.0 (0.8%)	0.3	0.0 (0.0%)
April	0.3	0.0 (-0.3%)	0.3	0.0 (-0.4%)	0.3	0.0 (0.1%)	0.3	0.0 (0.0%)
May	0.3	0.0 (-0.2%)	0.4	0.0 (-0.4%)	0.3	0.0 (0.1%)	0.4	0.0 (0.0%)
June	0.4	0.0 (0.0%)	0.7	0.0 (-0.1%)	0.4	0.0 (0.5%)	0.7	0.0 (0.0%)
July	1.0	0.0 (0.7%)	1.7	0.0 (0.9%)	1.0	0.0 (1.5%)	1.7	0.0 (0.0%)
August	1.6	0.0 (-0.1%)	2.2	0.0 (-0.3%)	1.6	0.0 (0.2%)	2.1	0.0 (0.0%)
September	1.9	0.0 (0.6%)	2.8	0.0 (0.9%)	1.9	0.0 (0.8%)	2.8	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAN018)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
mmhos/cm = millimhos per centimeter

Table 7-125. Simulated Number of Months of Exceedence of the Salinity Standard for the San Joaquin River at Jersey Point Under Baseline Conditions and CP5

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition	CP5 Change	Existing Condition	CP5 Change	No-Action Alternative	CP5 Change	No-Action Alternative	CP5 Change
	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))
October	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
November	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
December	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
January	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
April	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
May	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
June	10	0.0 (0.0%)	8	0.0 (0.0%)	13	0.0 (0.0%)	11	0.0 (0.0%)
July	51	0.0 (0.0%)	22	0.0 (0.0%)	50	1.0 (2.0%)	21	1.0 (4.8%)
August	73	0.0 (0.0%)	25	0.0 (0.0%)	76	-1.0 (-1.3%)	27	-1.0 (-3.7%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAN018)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan

Impact WQ-19c (CP5): Delta Salinity on the Sacramento River at Emmaton
On an average monthly basis, EC would meet the requirements in all months on an average annual basis; moreover, CP5 would not increase the EC at Emmaton during this period by more than 1.4 percent. This impact would be less than significant.

Impact WQ-19c (CP5) would be similar to Impact WQ-19c (CP1). Although Table 7-126 shows EC for all months, the Emmaton water quality requirement is only defined for April 1 through August 15. On an average monthly basis, EC would meet requirements in all months on an average annual basis. Table 7-127 shows the number of months simulated EC values exceeded the standards for the Sacramento River at Emmaton in the period of simulation. Operations of CP5 would not result in any violation of salinity standards between October and March. CP5 would result in an increase in the frequency of violations under existing and future conditions during May, by up to 33.3 percent in all years and dry and critical years. However, CP5 would result in a decrease in the frequency of violations under existing and future conditions during April and August, by up to 50 percent in the average of all years and dry and critical years. Overall, the compliance of salinity standards for the Sacramento River at Emmaton would be very similar to the baseline levels under both existing and future conditions. The impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-126. Simulated Monthly Average Salinity and Percent Change for the Sacramento River at Emmaton Under Baseline Conditions and CP5

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	CP5 Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	CP5 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP5 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP5 Change (mmhos/cm (%))
October	2.0	0.0 (-2.3%)	2.4	0.0 (-2.0%)	2.0	-0.1 (-2.6%)	2.5	0.0 (0.0%)
November	1.5	0.0 (-1.2%)	2.2	-0.1 (-2.5%)	1.5	0.0 (-1.2%)	2.3	0.0 (0.0%)
December	1.0	0.0 (-0.5%)	1.5	0.0 (-0.7%)	0.9	0.0 (-1.2%)	1.5	0.0 (0.0%)
January	0.5	0.0 (0.1%)	0.7	0.0 (0.4%)	0.4	0.0 (-0.7%)	0.7	0.0 (0.1%)
February	0.3	0.0 (0.5%)	0.4	0.0 (1.4%)	0.3	0.0 (0.4%)	0.4	0.0 (0.0%)
March	0.2	0.0 (-0.1%)	0.3	0.0 (-0.1%)	0.2	0.0 (0.7%)	0.3	0.0 (0.0%)
April	0.3	0.0 (-0.6%)	0.3	0.0 (-0.9%)	0.3	0.0 (-0.3%)	0.4	0.0 (0.0%)
May	0.3	0.0 (-0.5%)	0.5	0.0 (-0.6%)	0.3	0.0 (-0.6%)	0.6	0.0 (0.0%)
June	0.6	0.0 (0.0%)	1.1	0.0 (-0.1%)	0.6	0.0 (0.5%)	1.1	0.0 (0.0%)
July	0.7	0.0 (-0.9%)	1.3	0.0 (-1.4%)	0.8	0.0 (-1.2%)	1.4	0.0 (0.0%)
August	1.4	0.0 (-0.7%)	2.3	0.0 (-1.4%)	1.5	0.0 (-1.3%)	2.3	0.0 (0.0%)
September	1.6	0.0 (-2.8%)	3.0	-0.1 (-4.2%)	1.6	-0.1 (-3.6%)	3.1	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAC092)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
mmhos/cm = millimhos per centimeter

Table 7-127. Simulated Number of Months of Exceedence of the Salinity Standard for the Sacramento River at Emmaton Under Baseline Conditions and CP5

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition	CP5 Change	Existing Condition	CP5 Change	No-Action Alternative	CP5 Change	No-Action Alternative	CP5 Change
	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))
October	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
November	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
December	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
January	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
April	1	0.0 (0.0%)	1	0.0 (0.0%)	2	-1.0 (-50.0%)	2	-1.0 (-50.0%)
May	1	0.0 (0.0%)	1	0.0 (0.0%)	3	1.0 (33.3%)	3	1.0 (33.3%)
June	28	0.0 (0.0%)	18	0.0 (0.0%)	27	0.0 (0.0%)	19	0.0 (0.0%)
July	1	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)
August	69	-2.0 (-2.9%)	26	-2.0 (-7.7%)	70	-2.0 (-2.9%)	26	-2.0 (-7.7%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAC092)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan

Impact WQ-19d (CP5): Delta Salinity on the Old River at Rock Slough Impact WQ-19d (CP5) would be similar to Impact WQ-19d (CP1). On an average annual basis, all months except September through January under both the existing condition and future condition would be less than 150 mg/L. This impact would be less than significant.

Table 7-128 shows simulated monthly average chloride concentrations and percent change for Contra Costa Canal Pumping Plant No. 1. In average annual years, CP5 would not increase chlorides by more than 1.0 percent. Maximum change in chloride concentrations under the CP5 are less than 1.2 percent for dry and critical years. Change in chloride concentration would not affect compliance with the standard; it would already be exceeded under the basis of comparison.

Table 7-129 shows the number of days simulated chloride values exceeded the standards of 150 mg/L for Contra Costa Canal Pumping Plant No. 1 in the period of simulation. No daily violations of the chloride standards would occur under both existing and future conditions for CP5. Overall, CP5 would not alter the compliance level observed under the existing and future conditions.

Table 7-128. Simulated Monthly Average Chlorides and Percent Change for Contra Costa Canal Pumping Plant No. 1 Under Baseline Conditions and CP5

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mg/L)	CP5 Change (mg/L (%))	Existing Condition (mg/L)	CP5 Change (mg/L (%))	No-Action Alternative (mg/L)	CP5 Change (mg/L (%))	No-Action Alternative (mg/L)	CP5 Change (mg/L (%))
October	156.2	-0.5 (-0.3%)	175.6	-1.8 (-1.0%)	157.1	-0.5 (-0.3%)	176.7	0.0 (0.0%)
November	154.9	-1.2 (-0.8%)	177.7	-2.2 (-1.2%)	155.3	-1.0 (-0.6%)	181.1	-0.1 (-0.1%)
December	144.3	1.4 (1.0%)	178.3	0.0 (0.0%)	151.7	0.3 (0.2%)	186.7	-0.1 (-0.1%)
January	153.9	1.0 (0.7%)	183.5	1.8 (1.0%)	164.9	1.2 (0.7%)	197.1	0.1 (0.1%)
February	106.2	-0.2 (-0.2%)	112.3	0.6 (0.5%)	119.2	0.6 (0.5%)	115.5	0.1 (0.0%)
March	95.2	-0.9 (-1.0%)	92.3	0.0 (0.0%)	103.8	0.5 (0.5%)	95.6	0.0 (0.0%)
April	88.4	-0.6 (-0.7%)	86.6	-0.2 (-0.2%)	90.0	0.3 (0.4%)	85.4	0.0 (0.0%)
May	90.4	-0.3 (-0.3%)	92.3	-0.2 (-0.2%)	87.5	0.1 (0.1%)	87.2	0.0 (0.0%)
June	62.4	-0.1 (-0.1%)	75.8	-0.1 (-0.1%)	61.5	0.1 (0.1%)	75.4	0.0 (0.0%)
July	73.8	0.4 (0.5%)	111.3	0.9 (0.8%)	76.6	0.7 (0.9%)	115.5	0.0 (0.0%)
August	117.0	0.5 (0.4%)	182.4	1.2 (0.7%)	122.0	1.0 (0.8%)	186.3	0.0 (0.0%)
September	158.5	-0.2 (-0.1%)	210.3	-0.3 (-0.1%)	167.1	0.3 (0.2%)	208.4	0.0 (0.0%)

*Source: Version 8.0.6, DSM2 Existing and Future simulations EC at Old River at Rock Slough (Node CHCCC006) converted to chlorides at Contra Costa Canal Pumping Plant No. 1 using the equation EC*0.268-24*

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
EC = electrical conductivity
mg/L = milligrams per liter

Table 7-129. Simulated Number of Days by Month of Exceedence of the Chloride Standard for Contra Costa Canal Pumping Plant No. 1 Under Baseline Conditions and CP5

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition	CP5 Change	Existing Condition	CP5 Change	No-Action Alternative	CP5 Change	No-Action Alternative	CP5 Change
	(Number of days)	(Number of days (%))	(Number of days)	(Number of days (%))	(Number of days)	(Number of days (%))	(Number of days)	(Number of days (%))
October	17	0 (0%)	7	0 (0%)	17	0 (0%)	7	0 (0%)
November	16	0 (0%)	7	0 (0%)	16	0 (0%)	7	0 (0%)
December	14	0 (0%)	7	0 (0%)	15	0 (0%)	7	0 (0%)
January	13	0 (0%)	7	0 (0%)	16	0 (0%)	8	0 (0%)
February	5	0 (0%)	2	0 (0%)	7	0 (0%)	2	0 (0%)
March	3	0 (0%)	1	0 (0%)	5	0 (0%)	0	0 (0%)
April	1	0 (0%)	0	0 (0%)	1	0 (0%)	0	0 (0%)
May	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
June	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
July	3	0 (0%)	3	0 (0%)	3	0 (0%)	3	0 (0%)
August	10	0 (0%)	10	0 (0%)	11	0 (0%)	10	0 (0%)
September	18	0 (0%)	11	0 (0%)	20	0 (0%)	11	0 (0%)
Total	99	0 (0%)	54	0 (0%)	111	0 (0%)	56	0 (0%)

*Sourcer: Version 8.0.6, DSM2 Existing and Future simulations EC at Old River at Rock Slough (Node CHCCC006) converted to chlorides at Contra Costa Canal Pumping Plant No. 1 using the equation EC*0.268-24*

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.
Percentage values reported in parenthesis are reported as zero if the change is less than one day.

Key:
% = percent
CP = Comprehensive Plan
EC = electrical conductivity

Impact WQ-19e (CP5): Delta Water Quality on the Delta-Mendota Canal at Jones Pumping Plant This impact would be similar to Impact WQ-19e (CP1). The water quality requirement on the Delta-Mendota Canal at Jones Pumping Plant has two components, a chloride requirement and an EC requirement. Tables 7-130 and 7-131 show that CP5 would not cause exceedence of chloride thresholds. All increases in chloride concentrations would be less than 5 percent. Chloride values under CP5 would be similar to the baseline values under both existing and future conditions. Tables 7-132 and 7-133 show that increases in EC would be less than 1.0 percent and would not exceed the EC threshold. The impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-130. Simulated Monthly Average Chlorides and Percent Change for the Delta-Mendota Canal at the Jones Pumping Plant Under Baseline Conditions and CP5

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mg/L)	CP5 Change (mg/L (%))	Existing Condition (mg/L)	CP5 Change (mg/L (%))	No-Action Alternative (mg/L)	CP5 Change (mg/L (%))	No-Action Alternative (mg/L)	CP5 Change (mg/L (%))
October	107.1	-0.5 (-0.5%)	117.9	-1.4 (-1.2%)	105.1	-0.9 (-0.9%)	117.0	0.0 (0.0%)
November	105.8	-0.7 (-0.6%)	118.9	-0.9 (-0.7%)	103.1	-0.6 (-0.6%)	118.4	-0.1 (-0.1%)
December	124.1	0.8 (0.6%)	142.3	0.3 (0.2%)	118.1	0.8 (0.7%)	136.7	0.0 (0.0%)
January	141.4	0.1 (0.0%)	165.9	0.0 (0.0%)	129.5	0.1 (0.0%)	151.2	0.1 (0.0%)
February	123.6	-0.5 (-0.4%)	159.4	-0.7 (-0.5%)	113.7	-0.1 (0.0%)	148.2	0.0 (0.0%)
March	106.9	-0.6 (-0.5%)	157.9	-0.4 (-0.3%)	97.1	0.3 (0.3%)	146.9	0.0 (0.0%)
April	84.0	-0.1 (-0.1%)	123.4	-0.1 (-0.1%)	68.6	0.2 (0.2%)	108.4	0.0 (0.0%)
May	75.3	0.0 (0.0%)	106.4	-0.1 (-0.1%)	66.0	0.0 (0.0%)	97.7	0.0 (0.0%)
June	66.4	-0.1 (-0.1%)	81.4	0.0 (0.0%)	60.8	0.0 (0.0%)	75.6	0.0 (0.0%)
July	60.8	0.3 (0.5%)	83.1	0.9 (1.1%)	58.8	0.5 (0.8%)	82.1	0.0 (0.0%)
August	82.2	0.5 (0.7%)	121.9	1.3 (1.1%)	80.6	0.6 (0.8%)	121.2	0.0 (0.0%)
September	109.5	0.2 (0.2%)	145.0	0.9 (0.6%)	107.5	0.2 (0.2%)	141.7	0.0 (0.0%)

*Source: Version 8.0.6, DSM2 Existing and Future simulations (Node CHCDMC006) converted to chlorides using the equation EC*0.273-43.9)*

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
EC = electrical conductivity
mg/L = milligrams per liter

Table 7-131. Simulated Number of Days by Month of Exceedence of the Chloride Standard for the Delta-Mendota Canal at the Jones Pumping Plant Under Baseline Conditions and CP5

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years				Dry and Critical Years	
	Existing Condition	CP5 Change	Existing Condition	CP5 Change		CP5 Change	No-Action Alternative	CP5 Change
	(Number of days)	(Number of days (%))	(Number of days)	(Number of days (%))		(Number of days (%))	(Number of days)	(Number of days (%))
October	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
November	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
December	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
January	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
February	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
March	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
April	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
May	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
June	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
July	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
August	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
September	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
Total	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node CHCDMC006)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.
Percentage values reported in parenthesis are reported as zero if the change is less than one day.

Key:
% = percent
CP = Comprehensive Plan

Table 7-132. Simulated Monthly Average Salinity and Percent Change for the Delta-Mendota Canal at the Jones Pumping Plant Under Baseline Conditions and CP5

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	CP5 Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	CP5 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP5 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP5 Change (mmhos/cm (%))
October	0.6	0.0 (-0.4%)	0.6	0.0 (-0.9%)	0.5	0.0 (-0.6%)	0.6	0.0 (0.0%)
November	0.5	0.0 (-0.4%)	0.6	0.0 (-0.5%)	0.5	0.0 (-0.4%)	0.6	0.0 (0.0%)
December	0.6	0.0 (0.5%)	0.7	0.0 (0.1%)	0.6	0.0 (0.5%)	0.7	0.0 (0.0%)
January	0.7	0.0 (0.0%)	0.8	0.0 (0.0%)	0.6	0.0 (0.0%)	0.7	0.0 (0.0%)
February	0.6	0.0 (-0.3%)	0.7	0.0 (-0.4%)	0.6	0.0 (0.0%)	0.7	0.0 (0.0%)
March	0.6	0.0 (-0.4%)	0.7	0.0 (-0.2%)	0.5	0.0 (0.2%)	0.7	0.0 (0.0%)
April	0.5	0.0 (-0.1%)	0.6	0.0 (-0.1%)	0.4	0.0 (0.1%)	0.6	0.0 (0.0%)
May	0.4	0.0 (0.0%)	0.6	0.0 (0.0%)	0.4	0.0 (0.0%)	0.5	0.0 (0.0%)
June	0.4	0.0 (0.0%)	0.5	0.0 (0.0%)	0.4	0.0 (0.0%)	0.4	0.0 (0.0%)
July	0.4	0.0 (0.3%)	0.5	0.0 (0.7%)	0.4	0.0 (0.4%)	0.5	0.0 (0.0%)
August	0.5	0.0 (0.4%)	0.6	0.0 (0.8%)	0.5	0.0 (0.5%)	0.6	0.0 (0.0%)
September	0.6	0.0 (0.1%)	0.7	0.0 (0.5%)	0.6	0.0 (0.1%)	0.7	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node CHCDMC006)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
mmhos/cm = millimhos per centimeter

Table 7-133. Simulated Number of Months of Exceedence of the Salinity Standard for the Delta-Mendota Canal at the Jones Pumping Plant Under Baseline Conditions and CP5

Month	Existing Condition (2005)				Future Condition (2030)			
			Dry and Critical Years				Dry and Critical Years	
		CP5 Change	Existing Condition	CP5 Change		CP5 Change	No-Action Alternative	CP5 Change
		(Number of months (%))	(Number of months)	(Number of months (%))		(Number of months (%))	(Number of months)	(Number of months (%))
October	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
November	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
December	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
January	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
April	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
May	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
June	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
July	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
August	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node CHCDMC006)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan

Impact WQ-19f (CP5): Delta Water Quality in the West Canal at the Mouth of the Clifton Court Forebay This impact would be similar to Impact WQ-19f (CP1). The 250-mg/L chloride concentration standard at the West Canal would not be exceeded on an average annual or dry and critical year basis under CP5. CP5 would also not exceed EC thresholds. This impact would be less than significant.

Table 7-134 shows that maximum chloride concentrations under both existing and future project conditions are lower for CP5 than the 250 mg/L threshold. Maximum changes under both existing and future projection conditions are less than 1.5 percent. As shown in Table 7-135, the maximum change in EC values under existing and future project conditions would be less than 1 percent.

Table 7-134. Simulated Monthly Average Chlorides and Percent Change for West Canal at the Clifton Court Forebay Under Baseline Conditions and CP5

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mg/L)	CP5 Change (mg/L (%))	Existing Condition (mg/L)	CP5 Change (mg/L (%))	No-Action Alternative (mg/L)	CP5 Change (mg/L (%))	No-Action Alternative (mg/L)	CP5 Change (mg/L (%))
October	110.8	-0.6 (-0.5%)	124.3	-1.7 (-1.4%)	110.4	-1.0 (-0.9%)	125.1	0.0 (0.0%)
November	107.2	-0.4 (-0.4%)	123.4	-1.0 (-0.8%)	105.7	-0.2 (-0.2%)	124.8	-0.1 (-0.1%)
December	109.2	1.2 (1.1%)	131.8	0.3 (0.3%)	107.0	1.2 (1.1%)	131.1	0.0 (0.0%)
January	128.1	0.5 (0.4%)	154.3	0.9 (0.6%)	120.5	0.1 (0.1%)	145.3	0.1 (0.1%)
February	107.5	-0.5 (-0.5%)	134.7	-0.3 (-0.2%)	99.2	0.3 (0.3%)	124.2	0.0 (0.0%)
March	91.9	-0.6 (-0.7%)	132.1	-0.2 (-0.1%)	83.6	0.6 (0.7%)	122.4	0.0 (0.0%)
April	75.6	-0.1 (-0.2%)	110.3	-0.2 (-0.2%)	60.8	0.3 (0.6%)	96.4	0.0 (0.0%)
May	70.8	0.0 (0.0%)	99.9	-0.1 (-0.1%)	61.6	0.1 (0.1%)	91.6	0.0 (0.0%)
June	56.4	-0.1 (-0.1%)	73.4	0.0 (-0.1%)	51.8	0.0 (-0.1%)	68.6	0.0 (0.0%)
July	52.2	0.4 (0.8%)	82.6	1.1 (1.3%)	51.3	0.5 (0.9%)	82.3	0.0 (0.0%)
August	80.5	0.2 (0.3%)	128.2	0.5 (0.4%)	80.4	0.6 (0.7%)	127.5	0.0 (0.0%)
September	115.0	0.3 (0.2%)	157.5	0.9 (0.6%)	114.9	0.4 (0.3%)	154.7	0.0 (0.0%)

*Source: Version 8.0.6, DSM2 Existing and Future simulations (Node CHSWP003) converted to chlorides using the equation EC*0.273-43.9)*

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
EC = electrical conductivity
mg/L = milligrams per liter

Table 7-135. Simulated Monthly Average Salinity and Percent Change for West Canal at the Clifton Court Forebay Under Baseline Conditions and CP5

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	CP5 Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	CP5 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP5 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP5 Change (mmhos/cm (%))
October	0.6	0.0 (-0.4%)	0.6	0.0 (-1.0%)	0.6	0.0 (-0.6%)	0.6	0.0 (0.0%)
November	0.6	0.0 (-0.3%)	0.6	0.0 (-0.6%)	0.5	0.0 (-0.1%)	0.6	0.0 (-0.1%)
December	0.6	0.0 (0.8%)	0.6	0.0 (0.2%)	0.6	0.0 (0.8%)	0.6	0.0 (0.0%)
January	0.6	0.0 (0.3%)	0.7	0.0 (0.5%)	0.6	0.0 (0.1%)	0.7	0.0 (0.1%)
February	0.6	0.0 (-0.3%)	0.7	0.0 (-0.2%)	0.5	0.0 (0.2%)	0.6	0.0 (0.0%)
March	0.5	0.0 (-0.5%)	0.6	0.0 (-0.1%)	0.5	0.0 (0.5%)	0.6	0.0 (0.0%)
April	0.4	0.0 (-0.1%)	0.6	0.0 (-0.1%)	0.4	0.0 (0.3%)	0.5	0.0 (0.0%)
May	0.4	0.0 (0.0%)	0.5	0.0 (-0.1%)	0.4	0.0 (0.0%)	0.5	0.0 (0.0%)
June	0.4	0.0 (-0.1%)	0.4	0.0 (0.0%)	0.4	0.0 (0.0%)	0.4	0.0 (0.0%)
July	0.4	0.0 (0.4%)	0.5	0.0 (0.8%)	0.3	0.0 (0.5%)	0.5	0.0 (0.0%)
August	0.5	0.0 (0.2%)	0.6	0.0 (0.3%)	0.5	0.0 (0.5%)	0.6	0.0 (0.0%)
September	0.6	0.0 (0.2%)	0.7	0.0 (0.5%)	0.6	0.0 (0.2%)	0.7	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node CHSWP003)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
mmhos/cm = millimhos per centimeter

Table 7-136 shows the average number of days simulated chloride values exceeded the standards of 250 mg/L for the West Canal at the Clifton Court Forebay in a year. There would be no additional violations throughout the year under both existing and future project conditions. CP5 would not change the baseline compliance levels under both existing and future conditions.

As shown in Table 7-137, CP5 would not result in any additional violations of the salinity standards. CP5 would actually result in decreases in EC during several months of the year. CP5 would not change the baseline compliance levels under both existing and future conditions. The impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-136. Simulated Number of Days by Month of Exceedence of the Chloride Standard for the West Canal at the Clifton Court Forebay Under Baseline Conditions and CP5

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition	CP5 Change	Existing Condition	CP5 Change	No-Action Alternative	CP5 Change	No-Action Alternative	CP5 Change
	(Number of days)	(Number of days (%))	(Number of days)	(Number of days (%))	(Number of days)	(Number of days (%))	(Number of days)	(Number of days (%))
October	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
November	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
December	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
January	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
February	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
March	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
April	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
May	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
June	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
July	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
August	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
September	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)
Total	0	0 (0%)	0	0 (0%)	0	0 (0%)	0	0 (0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node CHSWP003)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.
Percentage values reported in parenthesis are reported as zero if the change is less than one day.

Key:
% = percent
CP = Comprehensive Plan

Table 7-137. Simulated Number of Months of Exceedence of the Salinity Standard for the West Canal at the Clifton Court Forebay Under Baseline Conditions and CP5

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition	CP5 Change	Existing Condition	CP5 Change	No-Action Alternative	CP5 Change	No-Action Alternative	CP5 Change
	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))
October	0	0.0 (0.0%)	0	0.0 (0.0%)	1	0.0 (0.0%)	0	0.0 (0.0%)
November	0	0.0 (0.0%)	0	0.0 (0.0%)	3	-3.0 (-100.0%)	2	-2.0 (-100.0%)
December	0	0.0 (0.0%)	0	0.0 (0.0%)	2	-1.0 (-50.0%)	1	0.0 (0.0%)
January	1	-1.0 (-100.0%)	1	-1.0 (-100.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
April	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
May	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
June	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
July	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
August	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node CHSWP003)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan

Impact WQ-19g (CP5): Delta Salinity on the San Joaquin River at Vernalis

This impact would be similar to Impact WQ-19g (CP1). On an average monthly basis, EC would meet requirements in all months in both average years and in dry and critical years. CP5 would not exceed EC thresholds on the San Joaquin River at Vernalis, as shown in Tables 7-138 and 7-139. CP5 would not change the baseline compliance levels under both existing and future conditions. The impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-138. Simulated Monthly Average Salinity and Percent Change for the San Joaquin River at Vernalis Under Baseline Conditions and CP5

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	CP5 Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	CP5 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP5 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP5 Change (mmhos/cm (%))
October	0.5	0.0 (0.0%)	0.5	0.0 (0.0%)	0.5	0.0 (0.0%)	0.5	0.0 (0.0%)
November	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)
December	0.8	0.0 (0.0%)	0.8	0.0 (0.0%)	0.7	0.0 (0.0%)	0.8	0.0 (0.0%)
January	0.8	0.0 (0.0%)	0.9	0.0 (0.0%)	0.7	0.0 (0.0%)	0.8	0.0 (0.0%)
February	0.7	0.0 (0.0%)	0.9	0.0 (0.0%)	0.7	0.0 (0.0%)	0.9	0.0 (0.0%)
March	0.6	0.0 (0.0%)	0.9	0.0 (0.0%)	0.6	0.0 (0.0%)	0.8	0.0 (0.0%)
April	0.4	0.0 (0.0%)	0.6	0.0 (0.0%)	0.4	0.0 (0.0%)	0.5	0.0 (0.0%)
May	0.4	0.0 (0.0%)	0.5	0.0 (0.0%)	0.4	0.0 (0.0%)	0.5	0.0 (0.0%)
June	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)
July	0.6	0.0 (0.0%)	0.7	0.0 (0.0%)	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)
August	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)
September	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAN112)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
mmhos/cm = millimhos per centimeter

Table 7-139. Simulated Number of Months of Exceedence of the Salinity Standard for the San Joaquin River at Vernalis Under Baseline Conditions and CP5

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition	CP5 Change	Existing Condition	CP5 Change	No-Action Alternative	CP5 Change	No-Action Alternative	CP5 Change
	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))
October	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
November	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
December	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
January	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
April	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
May	1	0.0 (0.0%)	1	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
June	1	0.0 (0.0%)	1	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
July	1	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)
August	3	0.0 (0.0%)	3	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAN112)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan

Impact WQ-19h (CP5): Delta Salinity on the San Joaquin River at Brandt Bridge This impact would be the same as Impact WQ-19h (CP1). On an average monthly basis, EC would meet requirements in all months in both average years and in dry and critical years. Moreover, CP5 would not measurably change EC on the San Joaquin River at Brandt Bridge. This impact would be less than significant.

This impact also would be similar to Impact WQ-19h (CP1). On an average monthly basis, EC would meet the requirements in all months in both average years and in dry and critical years. Moreover, CP5 would not measurably change EC on the San Joaquin River at Brandt Bridge, as shown in Table 7-140. Table 7-141 shows the number of months simulated EC values exceeded the standards for the San Joaquin River at Brandt Bridge in the period of simulation. CP5 would not change the existing compliance level for salinity standards for the San Joaquin River at Brandt Bridge. The impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-140. Simulated Monthly Average Salinity and Percent Change for the San Joaquin River at Brandt Bridge Under Baseline Conditions and CP5

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	CP5 Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	CP5 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP5 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP5 Change (mmhos/cm (%))
October	0.5	0.0 (0.0%)	0.5	0.0 (0.0%)	0.5	0.0 (0.0%)	0.5	0.0 (0.0%)
November	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)
December	0.8	0.0 (0.0%)	0.8	0.0 (0.0%)	0.7	0.0 (0.0%)	0.8	0.0 (0.0%)
January	0.8	0.0 (0.0%)	0.9	0.0 (0.0%)	0.7	0.0 (0.0%)	0.8	0.0 (0.0%)
February	0.7	0.0 (0.0%)	0.9	0.0 (0.0%)	0.7	0.0 (0.0%)	0.9	0.0 (0.0%)
March	0.6	0.0 (0.0%)	0.9	0.0 (0.0%)	0.6	0.0 (0.0%)	0.8	0.0 (0.0%)
April	0.4	0.0 (0.0%)	0.6	0.0 (0.0%)	0.4	0.0 (0.0%)	0.5	0.0 (0.0%)
May	0.4	0.0 (0.0%)	0.6	0.0 (0.0%)	0.4	0.0 (0.0%)	0.5	0.0 (0.0%)
June	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)
July	0.6	0.0 (0.0%)	0.7	0.0 (0.1%)	0.6	0.0 (0.0%)	0.7	0.0 (0.0%)
August	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)
September	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAN112)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
mmhos/cm = millimhos per centimeter

Table 7-141. Simulated Number of Months of Exceedence of the Salinity Standard for the San Joaquin River at Brandt Bridge Under Baseline Conditions and CP5

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition	CP5 Change	Existing Condition	CP5 Change	No-Action Alternative	CP5 Change	No-Action Alternative	CP5 Change
	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))
October	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
November	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
December	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
January	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
April	2	0.0 (0.0%)	2	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)
May	1	0.0 (0.0%)	1	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
June	1	0.0 (0.0%)	1	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
July	1	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)
August	2	0.0 (0.0%)	2	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RSAN112)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan

Impact WQ-19i (CP5): Delta Salinity on the Old River near the Middle River
On an average monthly basis, EC would meet requirements in all months in both average years and in dry and critical years. CP5 would not measurably change EC on the Old River near the Middle River, as shown in Table 7-142. This impact would be less than significant.

Table 7-143 shows the number of months simulated EC values exceeded the standards for the Old River near the Middle River in the period of simulation. Compliance with salinity standards for the Old River near the Middle River would not change under CP5 when compared to the existing conditions. The impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-142. Simulated Monthly Average Salinity and Percent Change for the Old River near Middle River Under Baseline Conditions and CP5

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	CP5 Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	CP5 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP5 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP5 Change (mmhos/cm (%))
October	0.5	0.0 (0.0%)	0.5	0.0 (0.0%)	0.5	0.0 (0.0%)	0.5	0.0 (0.0%)
November	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)
December	0.8	0.0 (0.0%)	0.8	0.0 (0.0%)	0.7	0.0 (0.0%)	0.8	0.0 (0.0%)
January	0.8	0.0 (0.0%)	0.9	0.0 (0.0%)	0.7	0.0 (0.0%)	0.8	0.0 (0.0%)
February	0.7	0.0 (0.0%)	0.9	0.0 (0.0%)	0.7	0.0 (0.0%)	0.9	0.0 (0.0%)
March	0.6	0.0 (0.0%)	0.9	0.0 (0.0%)	0.6	0.0 (0.0%)	0.8	0.0 (0.0%)
April	0.4	0.0 (0.0%)	0.6	0.0 (0.0%)	0.4	0.0 (0.0%)	0.5	0.0 (0.0%)
May	0.4	0.0 (0.0%)	0.6	0.0 (0.0%)	0.4	0.0 (0.0%)	0.5	0.0 (0.0%)
June	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)
July	0.6	0.0 (0.0%)	0.7	0.0 (0.0%)	0.6	0.0 (0.0%)	0.7	0.0 (0.0%)
August	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)
September	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RMID041)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
mmhos/cm = millimhos per centimeter

Table 7-143. Simulated Number of Months of Exceedence of the Salinity Standard for the Old River near Middle River Under Baseline Conditions and CP5

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition	CP5 Change	Existing Condition	CP5 Change	No-Action Alternative	CP5 Change	No-Action Alternative	CP5 Change
	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))
October	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
November	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
December	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
January	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
April	2	0.0 (0.0%)	2	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)
May	1	0.0 (0.0%)	1	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
June	1	0.0 (0.0%)	1	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
July	1	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)
August	2	0.0 (0.0%)	2	0.0 (0.0%)	1	0.0 (0.0%)	1	0.0 (0.0%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node RMID041)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan

Impact WQ-19j (CP5): Delta Salinity on the Old River at Tracy Road Bridge
This impact would be similar to Impact WQ-19j (CP1). On an average monthly basis, EC would meet requirements in all months in both average years and in dry and critical years. CP5 would not measurably change EC on the Old River at Tracy Road Bridge, as shown in Table 7-144. This impact would be less than significant.

Table 7-145 shows the number of months simulated EC values exceeded the standards for the Old River near Tracy Road Bridge in the period of simulation. Although exceedence would occur during August, under future conditions, on an annual average basis, the compliance of salinity standards under CP2 would not change from the existing conditions. Overall, CP5 would not change the baseline compliance levels under both existing and future conditions. The impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-144. Simulated Monthly Average Salinity and Percent Change for the Old River at Tracy Road Bridge Under Baseline Conditions and CP5

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (mmhos/cm)	CP5 Change (mmhos/cm (%))	Existing Condition (mmhos/cm)	CP5 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP5 Change (mmhos/cm (%))	No-Action Alternative (mmhos/cm)	CP5 Change (mmhos/cm (%))
October	0.5	0.0 (0.2%)	0.6	0.0 (0.3%)	0.5	0.0 (0.1%)	0.5	0.0 (0.0%)
November	0.6	0.0 (0.1%)	0.6	0.0 (0.1%)	0.6	0.0 (0.1%)	0.6	0.0 (0.0%)
December	0.8	0.0 (0.0%)	0.8	0.0 (0.0%)	0.7	0.0 (0.0%)	0.8	0.0 (0.0%)
January	0.8	0.0 (0.0%)	0.9	0.0 (0.0%)	0.7	0.0 (0.0%)	0.8	0.0 (0.0%)
February	0.7	0.0 (0.0%)	0.9	0.0 (0.0%)	0.7	0.0 (0.0%)	0.9	0.0 (0.0%)
March	0.6	0.0 (0.0%)	0.9	0.0 (0.0%)	0.6	0.0 (0.0%)	0.8	0.0 (0.0%)
April	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)	0.4	0.0 (0.0%)	0.6	0.0 (0.0%)
May	0.4	0.0 (0.0%)	0.6	0.0 (0.0%)	0.4	0.0 (0.0%)	0.5	0.0 (0.0%)
June	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)	0.5	0.0 (0.0%)	0.6	0.0 (0.0%)
July	0.6	0.0 (0.0%)	0.7	0.0 (-0.1%)	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)
August	0.6	0.0 (-0.1%)	0.6	0.0 (-0.2%)	0.6	0.0 (0.0%)	0.6	0.0 (0.0%)
September	0.6	0.0 (0.0%)	0.6	0.0 (-0.1%)	0.5	0.0 (0.1%)	0.6	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node ROLD059)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
mmhos/cm = millimhos per centimeter

Table 7-145. Simulated Number of Months of Exceedence of the Salinity Standard for the Old River at Tracy Road Bridge Under Baseline Conditions and CP5

Month	Existing Condition (2005)				Future Condition (2030)			
	Total All Years		Dry and Critical Years		Total All Years		Dry and Critical Years	
	Existing Condition	CP5 Change	Existing Condition	CP5 Change	No-Action Alternative	CP5 Change	No-Action Alternative	CP5 Change
	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))	(Number of months)	(Number of months (%))
October	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
November	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
December	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
January	1	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
February	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
March	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
April	7	0.0 (0.0%)	7	0.0 (0.0%)	5	0.0 (0.0%)	5	0.0 (0.0%)
May	1	0.0 (0.0%)	1	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
June	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
July	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)
August	4	0.0 (0.0%)	4	0.0 (0.0%)	3	2.0 (66.7%)	3	2.0 (66.7%)
September	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)	0	0.0 (0.0%)

Source: Version 8.0.6, DSM2 Existing and Future simulations (Node ROLD059)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan

Impact WQ-20 (CP5): X2 Position This impact would be similar to Impact WQ-20 (CP1). CP5 would not change average monthly X2 in either average years or in dry and critical years by more than 0.1 km under either the existing condition or future condition. Although several months may be out of compliance individually under the bases of comparison, the impact would be less than significant.

Table 7-146 shows the simulated monthly average X2 position for CP5 as compared to the existing condition and future condition baselines. CalSim-II calculates the X2 position on a 1-month delay; the values shown have been corrected to accurately reflect the X2 position for the specified month.

CP5 would not change average monthly X2 in either average years or in dry or critical years by more than 0.1 km under either the existing condition or the future condition. Although several months may be out of compliance under the bases of comparison, the change resulting from CP5 would not increase the amount out of compliance. The impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 7-146. Simulated Monthly Average X2 Position Under Baseline Conditions and CP5

Month	Existing Condition (2005)				Future Conditions (2030)			
	Average All Years		Dry and Critical Years		Average All Years		Dry and Critical Years	
	Existing Condition (km)	CP5 Change (km (%))	Existing Condition (km)	CP5 Change (km (%))	No-Action Alternative (km)	CP5 Change (km (%))	No-Action Alternative (km)	CP5 Change (km (%))
October	83.9	-0.1 (-0.1%)	86.6	-0.1 (-0.1%)	83.9	-0.1 (-0.1%)	86.5	0.0 (0.0%)
November	82.2	0.1 (0.1%)	86.5	-0.1 (-0.1%)	82.2	0.1 (0.1%)	86.6	0.0 (0.0%)
December	76.1	0.1 (0.1%)	84.8	0.0 (0.0%)	76.0	0.1 (0.1%)	84.7	0.0 (0.0%)
January	67.5	0.0 (0.0%)	79.6	0.0 (0.0%)	67.3	0.0 (0.0%)	79.2	0.0 (0.0%)
February	60.9	0.0 (0.1%)	72.5	0.1 (0.1%)	60.8	0.1 (0.1%)	72.3	0.0 (0.0%)
March	60.9	0.0 (0.1%)	70.3	0.0 (0.0%)	60.9	0.0 (0.0%)	70.3	0.0 (0.0%)
April	63.5	0.0 (-0.1%)	72.9	-0.1 (-0.1%)	63.4	0.0 (0.0%)	73.0	0.0 (0.0%)
May	67.5	0.0 (0.0%)	77.6	-0.1 (-0.1%)	67.7	0.0 (0.0%)	78.0	0.1 (0.1%)
June	74.5	0.0 (0.0%)	82.6	0.0 (-0.1%)	74.7	0.1 (0.1%)	82.8	0.0 (0.0%)
July	80.5	0.0 (0.0%)	86.1	0.0 (0.0%)	80.5	0.0 (0.1%)	86.1	0.0 (0.0%)
August	85.6	0.0 (0.0%)	88.8	-0.1 (-0.1%)	85.6	0.0 (0.0%)	88.6	0.0 (0.0%)
September	82.6	0.0 (-0.1%)	91.1	-0.1 (-0.2%)	82.6	-0.1 (-0.1%)	90.9	0.0 (0.0%)

Source: SLWRI 2012 Version CalSim-II model 2005 and 2030 simulations (Node X2_PRV)

Note:
Simulation period: 1922-2003. Change as measured from either Existing Condition or No-Action Alternative. Dry and critical years as defined by the Sacramento Valley Index.

Key:
% = percent
CP = Comprehensive Plan
km = kilometer
X2 = geographic location of 2 parts per thousand near-bottom salinity isohaline in the Delta, measured in distance upstream from Golden Gate Bridge in Suisun Bay.

7.3.5 Mitigation Measures

Table 7-147 presents a summary of mitigation measures for water quality.

Table 7-147. Summary of Mitigation Measures for Water Quality

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/CP4A	CP5
Impact WQ-1: Temporary Construction-Related Sediment Effects on Shasta Lake and Its Tributaries that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses	LOS before Mitigation	NI	PS	PS	PS	PS	PS
	Mitigation Measure	None required.	Mitigation Measure WQ-1: Develop and Implement a Comprehensive Multi-scale Sediment Reduction and Water Quality Improvement Program Within Watersheds Tributary to the Primary Study Area.				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS
Impact WQ-2: Temporary Construction-Related Temperature Effects on Shasta Lake and Its Tributaries that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses	LOS before Mitigation	NI	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS
Impact WQ-3: Temporary Construction-Related Metal Effects on Shasta Lake and Its Tributaries that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses	LOS before Mitigation	NI	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS
Impact WQ-4: Long-Term Sediment Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in Shasta Lake or Its Tributaries	LOS before Mitigation	NI	PS	PS	PS	PS	PS
	Mitigation Measure	None required.	Mitigation Measure WQ-4: Implement Mitigation Measure WQ-1 (CP1): Develop and Implement a Comprehensive Multi-scale Sediment Reduction and Water Quality Improvement Program Within Watersheds Tributary to the Primary Study Area.				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS

Table 7-147. Summary of Mitigation Measures for Water Quality (contd.)

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/CP4A	CP5
Impact WQ-5: Long-Term Temperature Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in Shasta Lake or Its Tributaries	LOS before Mitigation	NI	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS
Impact WQ-6: Long-Term Metals Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in Shasta Lake or Its Tributaries	LOS before Mitigation	LTS	PS	PS	PS	PS	PS
	Mitigation Measure	None required.	Mitigation Measure WQ-6: Prepare and Implement a Site-Specific Remediation Plan for Historic Mine Features Subject to Inundation in the Vicinity of the Bully Hill and Rising Star Mines.				
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
Impact WQ-7: Temporary Construction-Related Sediment Effects on the Upper Sacramento River that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses	LOS before Mitigation	NI	PS	PS	PS	PS	PS
	Mitigation Measure	None required.	Mitigation Measure WQ-7 (CP1–CP3): Implement Mitigation Measure WQ-1 (CP1): Develop and Implement a Comprehensive Multi-scale Sediment Reduction and Water Quality Improvement Program Within Watersheds Tributary to the Primary Study Area.				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS

Table 7-147. Summary of Mitigation Measures for Water Quality (contd.)

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/CP4A	CP5
Impact WQ-8: Temporary Construction-Related Temperature Effects on the Upper Sacramento River that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses	LOS before Mitigation	NI	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS
Impact WQ-9: Temporary Construction-Related Metal Effects on the Upper Sacramento River that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses	LOS before Mitigation	NI	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required	None needed; thus, none proposed				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS
Impact WQ-10: Long-Term Sediment Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Upper Sacramento River	LOS before Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required	None needed; thus, none proposed				
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
Impact WQ-11: Long-Term Temperature Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Upper Sacramento River	LOS before Mitigation	LTS	B	B	B	B	B
	Mitigation Measure	None required	None needed; thus, none proposed				
	LOS after Mitigation	LTS	B	B	B	B	B

Table 7-147. Summary of Mitigation Measures for Water Quality (contd.)

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/CP4A	CP5
Impact WQ-12: Long-Term Metals Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Upper Sacramento River	LOS before Mitigation	LTS	PS	PS	PS	PS	PS
	Mitigation Measure	None required	Mitigation Measure WQ-12: Implement Mitigation Measure WQ-6 (CP1): Prepare and Implement a Site-Specific Remediation Plan for Historic Mine Features Subject to Inundation in the Vicinity of the Bully Hill and Rising Star Mines				
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
Impact WQ-13: Temporary Construction-Related Sediment Effects on the Extended Study Area that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses	LOS before Mitigation	NI	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required	None needed; thus, none proposed				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS
Impact WQ-14: Temporary Construction-Related Temperature Effects on the Extended Study Area that Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses	LOS before Mitigation	NI	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required	None needed; thus, none proposed				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS
Impact WQ-15: Temporary Construction-Related Metal Effects on the Extended Study Area that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses	LOS before Mitigation	NI	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required	None needed; thus, none proposed				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS

Table 7-147. Summary of Mitigation Measures for Water Quality (contd.)

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/CP4A	CP5
Impact WQ-16: Long-Term Sediment Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Extended Study Area	LOS before Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required	None needed; thus, none proposed				
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
Impact WQ-17: Long-Term Temperature Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Extended Study Area	LOS before Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required	None needed; thus, none proposed				
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
Impact WQ-18: Long-Term Metals Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Extended Study Area	LOS before Mitigation	LTS	PS	PS	PS	PS	PS
	Mitigation Measure	Non required	Mitigation Measure WQ-18: Implement Mitigation Measure WQ-6 (CP1): Prepare and Implement a Site-Specific Remediation Plan for Historic Mine Features Subject to Inundation in the Vicinity of the Bully Hill and Rising Star Mines				
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
Impact WQ-19a: Delta Salinity on the Sacramento River at Collinsville	LOS before Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required	None needed; thus, none proposed				
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS

Table 7-147. Summary of Mitigation Measures for Water Quality (contd.)

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/CP4A	CP5
Impact WQ-19b: Delta Salinity on the San Joaquin River at Jersey Point	LOS before Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required	None needed; thus, none proposed				
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
Impact WQ-19c: Delta Salinity on the Sacramento River at Emmaton	LOS before Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required	None needed; thus, none proposed				
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
Impact WQ-19d: Delta Salinity on the Old River at Rock Slough	LOS before Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required	None needed; thus, none proposed				
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
Impact WQ-19e: Delta Water Quality on the Delta-Mendota Canal at Jones Pumping Plant	LOS before Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required	None needed; thus, none proposed				
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS

Table 7-147. Summary of Mitigation Measures for Water Quality (contd.)

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/CP4A	CP5
Impact WQ-19f: Delta Water Quality on the West Canal at the Mouth of the Clifton Court Forebay	LOS before Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required	None needed; thus, none proposed				
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
Impact WQ-19g: Delta Salinity on the San Joaquin River at Vernalis	LOS before Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required	None needed; thus, none proposed				
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
Impact WQ-19h: Delta Salinity on the San Joaquin River at Brandt Bridge	LOS before Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed				
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
Impact WQ-19i: Delta Salinity on the Old River near the Middle River	LOS before Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed				
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS

Table 7-147. Summary of Mitigation Measures for Water Quality (contd.)

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/CP4A	CP5
Impact WQ-19j: Delta Salinity on the Old River at Tracy Road Bridge	LOS before Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed				
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
Impact WQ-20: X2 Position	LOS before Mitigation	PS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed				
	LOS after Mitigation	SU	LTS	LTS	LTS	LTS	LTS

Key:
B = beneficial
CP = Comprehensive Plan
LOS = level of significance
LTS = less than significant
NI = no impact
PS = potentially significant
SU = significant and unavoidable

No-Action Alternative

Under the No-Action Alternative, no action would be taken, including implementation of mitigation measures; rather, existing conditions would continue to change into the future. No mitigation measures are required for the No-Action Alternative. Thus, Impact WQ-20 (No-Action) would be significant and unavoidable.

CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

No mitigation measures are needed for Impacts WQ-2 (CP1), WQ-3 (CP1), WQ-5 (CP1), WQ-8 (CP1) through WQ-11 (CP1), WQ-13 (CP1) through WQ-17 (CP1), WQ-19a (CP1) through WQ-19j (CP1), and WQ-20 (CP1). Mitigation is provided below for the remaining impacts of CP1 on water quality.

Mitigation Measure WQ-1 (CP1): Develop and Implement a Comprehensive Multi-scale Sediment Reduction and Water Quality Improvement Program Within Watersheds Tributary to the Primary Study Area. The type and nature of actions described in Chapter 2 of the EIS will require a wide array of mitigation activities to reduce sediment impacts to Shasta Lake and the upper Sacramento River. Watershed analysis and assessments prepared for most of the watersheds tributary to these water bodies consistently document that roads and modified fire regimes have increased sediment contributions to receiving waters, particularly in those watersheds that have been subjected to mining, forest management, and other types of large-scale developments (CVWRCB 2011, The River Exchange 2010).

This mitigation measure focuses on proactive activities intended to reduce sediment delivery to receiving waters using a framework approach. At this point in Reclamation’s planning process, there is substantial uncertainty with respect to the specific location and types of mitigation activities that may be appropriate and/or effective. At a minimum, the framework includes four fundamental components intended to meet the primary objectives of reducing sediment impacts and improving water quality. These components are generally consistent with the type of management opportunities identified in the Upper Sacramento River Watershed Assessment and Management Strategy (The River Exchange 2010):

- Stabilize and/or remediate localized point-source locations that are directly affecting waters tributary to Shasta Lake and/or the upper Sacramento River (e.g., active landslides).

- Reduce road-related sediment and improve hydrologic functions by implementing erosion prevention and sediment control and stormproofing measures at the appropriate scale (5th-field watersheds).

- Use fuels and vegetation management techniques to manage fuel loads in a manner that restores ecological processes with the intention of reducing the potential for large-scale, high-intensity wildfires (like the Bagley fire) that often result in wide-spread erosion and water quality impacts. This mitigation element may be implemented at multiple scales, but likely planning efforts would focus on the scale of 5th-field watersheds to effectively mitigate impacts to water quality and other landscape values.

- Stabilize and/or restore channels using both active (construction) and passive (revegetation) measures that reestablish form and function in a manner that improves water quality. This component is consistent with the objectives for Mitigation Measure Geo-2 (Chapter 4).

The following discussion is intended to demonstrate Reclamation's commitment to using the best science available to fully develop and implement this mitigation measure in a manner that fully mitigates impact WQ-1 for CP1. Reclamation acknowledges that efforts are ongoing to fully develop this mitigation measure; however the approach outlined below describes efforts to date to identify a number of site-specific actions intended to reduce road-related sediment and improve the hydrologic function of existing roads within the watersheds encompassed by BLM's Shasta-Chappie Off-Highway Vehicle (OHV) area – drainages that enter the Main Arm of Shasta Lake. Reclamation is committed to inventorying road-related sediment sources, prioritizing corrective actions, and implementing mitigation projects in other watersheds tributary to the arms of Shasta Lake (e.g., McCloud, Squaw Creek).

With an understanding that off-site, out-of-kind mitigation would be required for WQ-1, Reclamation initiated a Sediment Source Inventory (SSI) of 113 miles of road and OHV trails throughout the OHV area (Reclamation 2013) in cooperation with the BLM and other land owners. This SSI included a road analysis process (RAP) developed by the USFS (USFS 1999) that was used to prioritize road-related projects intended to reduce sediment impacts and improve water quality in the watersheds contributing to Shasta Lake.

Using this RAP approach, 32-miles of road segments inventoried were considered a moderate-high to high risk. Seven out of the 19 moderate-high to high risk roads are located within the South Fork Squaw Creek and Dry Creek drainages that are tributary to the Main Arm of Shasta Lake. Within these drainages, approximately 20 miles of roads received a high risk rating. The amount of sediment reduction that occurs through road stabilization, stormproofing, and/or decommissioning can be assessed through the WEPP model developed for the USFS (USFS 2010).

The WEPP model provides a tool that can be used to characterize the benefits of Mitigation Measure WQ-1 for various types of mitigation components. An example of this has been developed for the road restoration and stabilization opportunities identified in the Westside Lands SSI.

For example, for each mitigation treatment an "x" amount of sediment reduction occurs with "y" number of mitigation treatments. In the sediment budget approach, the amount of sediment produced as a result of short-term construction impacts and long-term shoreline erosion would be offset by a combination of the mitigation of these disturbances with various types of mitigation treatments in high priority areas identified through the RAP process and other applicable criteria developed through the mitigation planning process.

Implementation of this mitigation measure would reduce Impact WQ-1 (CP1) to a less-than-significant level.

Mitigation Measure WQ-4 (CP1): Implement Mitigation Measure WQ-1 (CP1) to Reduce Long-Term Effects on Shasta Lake and Its Tributaries Related to Sediment Reclamation will implement Mitigation Measure WQ-1 (CP1) as described above to reduce long-term effects related to sediment. The SWPPP may be customized to address long-term construction-related impacts associated with this impact. Implementation of this mitigation measure would reduce Impact WQ-4 (CP1) to a less-than-significant level.

Customization of Mitigation Measure WQ-4 (CP1) to address long-term construction-related impacts will be completed in a similar manner to Mitigation Measure WQ-1 (CP1), described above. The application of the shoreline erosion model with WEPP can be used to customize Mitigation Measure WQ-4 (CP1). The mitigation activities and treatments would be modified to address long-term construction impacts as predicted by the models.

Mitigation Measure WQ-6 (CP1): Prepare and Implement a Site-Specific Remediation Plan for Historic Mine Features Subject to Inundation in the Vicinity of the Bully Hill and Rising Star Mines Reclamation will prepare and implement a plan to remove or otherwise remediate two sites related to historic mining activities that have the potential to introduce metals into Shasta Lake, a Section 303(d)-listed water body. This plan will include requirements to coordinate with Federal, State, and local agencies and landowners to ensure that measures taken will reduce the potential for a discharge of metals into Shasta Lake. Reclamation will obtain any required permits, approvals, and authorizations before any ground-disturbing remediation activity occurs.

Implementation of this mitigation measure would reduce Impact WQ-6 (CP1) to a less-than-significant level.

Mitigation Measure WQ-7 (CP1): Implement Mitigation Measure WQ-1 (CP1) to Reduce Temporary Construction-Related Effects on the Upper Sacramento River Related to Sediment Reclamation will implement Mitigation Measure WQ-1 (CP1) as described above to reduce temporary construction-related effects related to sediment. Implementation of this mitigation measure would reduce Impact WQ-7 (CP1) to a less-than-significant level.

Mitigation Measure WQ-12 (CP1): Implement Mitigation Measure WQ-6 (CP1) to Reduce Long-Term Metals Effects on the Upper Sacramento River Reclamation will implement Mitigation Measure WQ-6 (CP1) as described above to reduce long-term metals effects. Implementation of this mitigation measure would reduce Impact WQ-12 (CP1) to a less-than-significant level.

Mitigation Measure WQ-18 (CP1): Implement Mitigation Measure WQ-6 (CP1) to Reduce Long-Term Metals Effects on the Extended Study Area Reclamation will implement Mitigation Measure WQ-6 (CP1) as described above to reduce long-term metals effects. Implementation of this mitigation measure would reduce Impact WQ-18 (CP1) to a less-than-significant level.

CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

No mitigation measures are needed for Impacts WQ-2 (CP2), WQ-3 (CP2), WQ-5 (CP2), WQ-8 (CP2) through WQ-11 (CP2), WQ-13 (CP2) through WQ-17 (CP2), WQ-19a (CP2) through WQ-19j (CP2), and WQ-20 (CP2). Mitigation is provided below for the remaining impacts of CP2 on water quality.

Mitigation Measure WQ-1 (CP2): Develop and Implement a Comprehensive Multi-scale Sediment Reduction and Water Quality Improvement Program Within Watersheds Tributary to the Primary Study Area. This mitigation measure is similar to Mitigation Measure WQ-1 (CP1); however, it will be modified to increase the number of mitigation activities and treatments to address the predicted increase in erosional impacts associated with CP2. Implementation of this mitigation measure would reduce Impact WQ-1 (CP2) to a less-than-significant level.

Mitigation Measure WQ-4 (CP2): Implement Mitigation Measure WQ-4 (CP1) to Reduce Long-Term Effects on Shasta Lake and Its Tributaries Related to Sediment Reclamation will implement Mitigation Measure WQ-4 (CP1) as described above to reduce long-term effects related to sediment. Implementation of this mitigation measure would reduce Impact WQ-4 (CP2) to a less-than-significant level.

Mitigation Measure WQ-6 (CP2): Prepare and Implement a Site-Specific Remediation Plan for Historic Mine Features Subject to Inundation in the Vicinity of the Bully Hill and Rising Star Mines This mitigation measure is identical to Mitigation Measure WQ-6 (CP1). Implementation of this mitigation measure would reduce Impact WQ-6 (CP2) to a less-than-significant level.

Mitigation Measure WQ-7 (CP2): Implement Mitigation Measure WQ-1 (CP1) to Reduce Temporary Construction-Related Effects on the Upper Sacramento River Related to Sediment Reclamation will implement Mitigation Measure WQ-1 (CP1) as described above to reduce temporary construction-related effects related to sediment. Implementation of this mitigation measure would reduce Impact WQ-7 (CP2) to a less-than-significant level.

Mitigation Measure WQ-12 (CP2): Implement Mitigation Measure WQ-6 (CP1) to Reduce Long-Term Metals Effects on the Upper Sacramento River Reclamation will implement Mitigation Measure WQ-6 (CP1) as described above to reduce long-term metals effects. Implementation of this mitigation measure would reduce Impact WQ-12 (CP2) to a less-than-significant level.

Mitigation Measure WQ-18 (CP2): Implement Mitigation Measure WQ-6 (CP1) to Reduce Long-Term Metals Effects on the Extended Study Area Reclamation will implement Mitigation Measure WQ-6 (CP1) as described above to reduce long-term metals effects. Implementation of this mitigation measure would reduce Impact WQ-18 (CP2) to a less-than-significant level.

CP3 – 18.5-Foot Dam Raise, Agricultural Water Supply Reliability and Anadromous Fish Survival

No mitigation measures are needed for Impacts WQ-2 (CP3), WQ-3 (CP3), WQ-5 (CP3), WQ-8 (CP3) through WQ-11 (CP3), WQ-13 (CP3) through WQ-17 (CP3), WQ-19a (CP3) through WQ-19j (CP3), and WQ-20 (CP3). Mitigation is provided below for the remaining impacts of CP3 on water quality.

Mitigation Measure WQ-1 (CP3): Develop and Implement a Comprehensive Multi-scale Sediment Reduction and Water Quality Improvement Program Within Watersheds Tributary to the Primary Study Area. This mitigation measure is similar Mitigation Measure WQ-1 (CP1); however, it will be modified to increase the number of mitigation activities and treatments to address the predicted increase in erosional impacts associated with CP3. Implementation of this mitigation measure would reduce Impact WQ-1 (CP3) to a less-than-significant level.

Mitigation Measure WQ-4 (CP3): Implement Mitigation Measure WQ-4 (CP1) to Reduce Long-Term Effects on Shasta Lake and Its Tributaries Related to Sediment Reclamation will implement Mitigation Measure WQ-4 (CP1) as described above to reduce long-term effects related to sediment. Implementation of this mitigation measure would reduce Impact WQ-4 (CP3) to a less-than-significant level.

Mitigation Measure WQ-6 (CP3): Prepare and Implement a Site-Specific Remediation Plan for Historic Mine Features Subject to Inundation in the

Vicinity of the Bully Hill and Rising Star Mines This mitigation measure is identical to Mitigation Measure WQ-6 (CP1). Implementation of this mitigation measure would reduce Impact WQ-6 (CP3) to a less-than-significant level.

Mitigation Measure WQ-7 (CP3): Implement Mitigation Measure WQ-1 (CP1) to Reduce Temporary Construction-Related Effects on the Upper Sacramento River Related to Sediment Reclamation will implement Mitigation Measure WQ-1 (CP1) as described above to reduce temporary construction-related effects related to sediment. Implementation of this mitigation measure would reduce Impact WQ-7 (CP3) to a less-than-significant level.

Mitigation Measure WQ-12 (CP3): Implement Mitigation Measure WQ-6 (CP1) to Reduce Long-Term Metals Effects on the Upper Sacramento River Reclamation will implement Mitigation Measure WQ-6 (CP1) as described above to reduce long-term metals effects. Implementation of this mitigation measure would reduce Impact WQ-12 (CP3) to a less-than-significant level.

Mitigation Measure WQ-18 (CP3): Implement Mitigation Measure WQ-6 (CP1) to Reduce Long-Term Metals Effects on the Extended Study Area Reclamation will implement Mitigation Measure WQ-6 (CP1) as described above to reduce long-term metals effects. Implementation of this mitigation measure would reduce Impact WQ-18 (CP3) to a less-than-significant level.

CP4 and CP4A – 18.5-Foot Dam Raise, Anadromous Fish Focus with Water Supply Reliability

No mitigation measures are needed for Impacts WQ-2 (CP4 and CP4A), WQ-3 (CP4 and CP4A), WQ-5 (CP4 and CP4A), WQ-8 (CP4 and CP4A) through WQ-11 (CP4 and CP4A), WQ-13 (CP4 and CP4A) through WQ-17 (CP4 and CP4A), WQ-19a (CP4 and CP4A) through WQ-19j (CP4 and CP4A), and WQ-20 (CP4 and CP4A). Mitigation is provided below for the remaining impacts of CP4 or CP4A on water quality.

Mitigation Measure WQ-1 (CP4 and CP4A): Develop and Implement a Comprehensive Multi-scale Sediment Reduction and Water Quality Improvement Program Within Watersheds Tributary to the Primary Study Area. This mitigation measure is identical to Mitigation Measure WQ-1 (CP3). Implementation of this mitigation measure would reduce Impact WQ-1 (CP4 and CP4A) to a less-than-significant level.

Mitigation Measure WQ-4 (CP4 and CP4A): Implement Mitigation Measure WQ-4 (CP1) to Reduce Long-Term Effects on Shasta Lake and Its Tributaries Related to Sediment Reclamation will implement Mitigation Measure WQ-4 (CP3) as described above to reduce long-term effects related to sediment. Implementation of this mitigation measure would reduce Impact WQ-4 (CP4 and CP4A) to a less-than-significant level.

Mitigation Measure WQ-6 (CP4 and CP4A): Prepare and Implement a Site-Specific Remediation Plan for Historic Mine Features Subject to Inundation in the Vicinity of the Bully Hill and Rising Star Mines This mitigation measure is identical to Mitigation Measure WQ-6 (CP1). Implementation of this mitigation measure would reduce Impact WQ-6 (CP4 and CP4A) to a less-than-significant level.

Mitigation Measure WQ-7 (CP4 and CP4A): Implement Mitigation Measure WQ-1 (CP1) and Gravel Augmentation BMPs to Reduce Temporary Construction-Related Effects on the Upper Sacramento River Related to Sediment Reclamation will implement (a) Mitigation Measure WQ-1 (CP3) as described above; and (b) specific BMPs for the gravel augmentation program. Gravel augmentation BMPs will include, but will not be limited to:

- **Construction Work Windows** – All gravel augmentation construction activities will be conducted outside of the flood season (e.g., June 15 to September 15).

- **Source and Handle Gravel So As to Minimize Potential Water Quality Impacts** – Gravel will be sorted and transported in a manner that minimizes potential water quality impacts (e.g., management of fine sediments). Gravel will be washed at least once and have a cleanliness value of 85 or higher based on California Department of Transportation Test No. 227. Gravel will also be completely free of oils, clay, debris, and organic material.

- **Minimize Potential Impacts Associated with Equipment Contaminants** – For in-river work, all equipment will be steam cleaned every day to remove hazardous materials before the equipment enters the water.

- **Implement Feasible Spill Prevention and Hazardous Materials Management** – The accidental release of chemicals, fuels, lubricants, and non-storm drainage water into channels will be prevented to the extent feasible. Spill prevention kits will always be in close proximity when using hazardous materials (e.g., crew trucks and other logical locations). Feasible measures will be implemented to ensure that hazardous materials are properly handled and the quality of aquatic resources is protected by all reasonable means. No fueling will be done within the ordinary high-water mark or immediate floodplain, unless equipment stationed in these locations is not readily relocated (i.e., pumps, generators). For stationary equipment that must be fueled on site, containments will be provided in such a manner that any accidental spill of fuel will not be able to enter the water or contaminate sediments that may come in contact with water. Any equipment that is readily moved out of the channel will not be fueled in the channel or immediate floodplain. All fueling done at the construction site will provide containment to the degree that any spill will be unable to enter the channel or damage wetland or riparian vegetation. No equipment servicing will be done within the ordinary high-water mark or immediate floodplain, unless equipment stationed in these locations cannot be readily relocated (i.e., pumps, generators). Additional BMPs designed to avoid spills from construction equipment and subsequent contamination of waterways will also be implemented.

- **Minimize Potential Impacts Associated with Access and Staging** – Existing access roads will be used. Equipment staging areas will be located outside of the ordinary high-water mark and away from sensitive resources.

- **Remove Temporary Fills as Appropriate** – Temporary fill, such as for access, side channel diversions, and/or side channel cofferdams, will be completely removed upon the completion of construction.

Implementation of this mitigation measure would reduce Impact WQ-7 (CP4 and CP4A) to a less-than-significant level.

Mitigation Measure WQ-12 (CP4 and CP4A): Implement Mitigation Measure WQ-6 (CP1) to Reduce Long-Term Metals Effects on the Upper Sacramento River Reclamation will implement Mitigation Measure WQ-6 (CP1) as described above to reduce long-term metals effects. Implementation of this mitigation measure would reduce Impact WQ-12 (CP4 and CP4A) to a less-than-significant level.

Mitigation Measure WQ-18 (CP4 and CP4A): Implement Mitigation Measure WQ-6 (CP1) to Reduce Long-Term Metals Effects on the Extended Study Area Reclamation will implement Mitigation Measure WQ-6 (CP1) as described above to reduce long-term metals effects. Implementation of this mitigation measure would reduce Impact WQ-18 (CP4 and CP4A) to a less-than-significant level.

CP5 – 18.5-Foot Dam Raise, Combination Plan

No mitigation measures are needed for Impacts WQ-2 (CP5), WQ-3 (CP5), WQ-5 (CP5), WQ-8 (CP5) through WQ-11 (CP5), WQ-13 (CP5) through WQ-17 (CP5), WQ-19a (CP5) through WQ-19j (CP5), and WQ-20 (CP5). Mitigation is provided below for the remaining impacts of CP5 on water quality.

Mitigation Measure WQ-1 (CP5): Develop and Implement a Comprehensive Multi-scale Sediment Reduction and Water Quality Improvement Program Within Watersheds Tributary to the Primary Study Area. This mitigation measure is identical to Mitigation Measure WQ-1

(CP3). Implementation of this mitigation measure would reduce Impact WQ-1 (CP5) to a less-than-significant level.

Mitigation Measure WQ-4 (CP5): Implement Mitigation Measure WQ-4 (CP1) to Reduce Long-Term Effects on Shasta Lake and Its Tributaries Related to Sediment Reclamation will implement Mitigation Measure WQ-4 (CP3) as described above to reduce long-term effects related to sediment. Implementation of this mitigation measure would reduce Impact WQ-4 (CP5) to a less-than-significant level.

Mitigation Measure WQ-6 (CP5): Prepare and Implement a Site-Specific Remediation Plan for Historic Mine Features Subject to Inundation in the Vicinity of the Bully Hill and Rising Star Mines This mitigation measure is identical to Mitigation Measure WQ-6 (CP1). Implementation of this mitigation measure would reduce Impact WQ-6 (CP5) to a less-than-significant level.

Mitigation Measure WQ-7 (CP5): Implement Mitigation Measure WQ-1 (CP1) and Gravel Augmentation BMPs to Reduce Temporary Construction-Related Effects on the Upper Sacramento River Related to Sediment This mitigation measure is identical to Mitigation Measure WQ-7 (CP4 and CP4A). Implementation of this mitigation measure would reduce Impact WQ-7 (CP5) to a less-than-significant level.

Mitigation Measure WQ-12 (CP5): Implement Mitigation Measure WQ-6 (CP1) to Reduce Long-Term Metals Effects on the Upper Sacramento River Reclamation will implement Mitigation Measure WQ-6 (CP1) as described above to reduce long-term metals effects. Implementation of this mitigation measure would reduce Impact WQ-12 (CP5) to a less-than-significant level.

Mitigation Measure WQ-18 (CP5): Implement Mitigation Measure WQ-6 (CP1) to Reduce Long-Term Metals Effects on the Extended Study Area Reclamation will implement Mitigation Measure WQ-6 (CP1) as described above to reduce long-term metals effects. Implementation of this mitigation measure would reduce Impact WQ-18 (CP5) to a less-than-significant level.

7.3.6 Cumulative Effects

Chapter 3, "Considerations for Describing the Affected Environment and Environmental Consequences," discusses overall cumulative impacts methodology related to the action alternatives, including the relationship to the CALFED Bay-Delta Program Programmatic EIS/EIR cumulative impacts analysis, qualitative and quantitative assessment, past and future actions in the study area, and significance criteria. Table 3-1, "Present and Reasonably Foreseeable Future Actions Included in the Analysis of Cumulative Impacts, by Resource Area," lists the present and reasonably foreseeable future projects considered quantitatively and qualitatively within the cumulative impacts analysis. This section analyzes the overall cumulative impacts of the action alternatives with other past, present, and reasonably foreseeable future projects that would produce related impacts.

Actions which are included quantitatively in this cumulative effects analysis are those that are reasonably foreseeable, including actions with current authorization, secured funding for design and construction, and environmental permitting and compliance activities that are substantially complete. As described in Chapter 2, "Alternatives," Section 2.2, "No-Action Alternative," the NEPA No-Action alternative includes all reasonably foreseeable actions included quantitatively in the cumulative effects analysis, but excludes effects for project actions. The future with-project conditions combine project actions with the actions included in the No-Action Alternative (2030 baseline). Therefore, quantitative impact assessments for the future with-project conditions presented in this chapter in Section 7.3, "Environmental Consequences and Mitigation Measures." With mitigation, none of the action alternatives would combine with the projects considered for quantitative cumulative impact analysis to contribute to a cumulatively considerable water quality impact.. Therefore, this section evaluates only those projects listed in Table 3-1, "Present and Reasonably Foreseeable Future Actions Included in the Analysis of Cumulative Impacts, by Resource Area," that are qualitatively considered in this EIS.

Past effects to water quality in the primary and extended study area include land uses, water diversions, wastewater discharge, non-point source pollution, and historic mining activities. Because of the substantial degradation in water quality in the primary and extended study areas when considering past, present, and reasonably foreseeable projects, and as identified in the existing conditions presented in this chapter, a significant cumulative impact would occur on water quality overall under both existing and future conditions. These cumulative impacts are occurring without the proposed action (e.g., 2012 Bagley fire). Several factors could substantially affect water quality in both the primary and extended study areas as an outcome of reasonably foreseeable future actions, but the potential effects are highly uncertain and may result in either beneficial or adverse short-term or long-term impacts on water quality in the study areas. Example projects listed in Table 3-1, "Present and Reasonably Foreseeable Future Actions Included in the Analysis of Cumulative Impacts, by Resource Area," that could contribute to cumulative impacts in the primary and extended study areas include, but are not limited to, the San Joaquin River Restoration Program, Bay-Delta Conservation Plan, Iron Mountain Mine Restoration Plan, North of Delta Offstream Storage Facility, and Delta Islands and Levees Feasibility Study.

The effect of climate change on operations at Shasta Lake could potentially result in changes to water quality. As described in the Climate Change Projection Appendix, climate change could result in higher inflows to Shasta Lake in the winter and early spring due to a shift from precipitation falling as snow to rain. This change could result in both higher Shasta Lake releases in the winter and spring to manage the increased potential for flood events, and an increase in water temperature for Shasta Lake inflows. A corresponding decrease in Shasta Lake releases in the summer and fall and a decrease in operable cold-water volume could result in warmer flows downstream.

CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

CP1 would not result in adverse changes to sediment, metals, and temperature, and therefore would not make a cumulatively considerable incremental contribution to an overall significant cumulative impact on water quality.

Without mitigation, CP1 could cause potentially significant effects on water quality in the primary study area. These effects could be caused temporarily or for the short term by construction-related activities that cause sediment, petroleum, or other substances to enter waterways in runoff. Mitigation measures would eliminate these effects or reduce them to a less-than-significant level.

CP1 would also affect water quality by increasing the volume of water in the reservoir and by altering downstream river flows. The effects on water quality resulting from these hydrologic alterations would be long term and much greater than the temporary and short-term effects related to construction.

Hydrologic modeling output predicts that hydrologically, CP1 would result in a small change in reservoir storage and minimal change in river flows relative to the No-Action Alternative. A small increase in the volume of water stored in the reservoir under CP1 could result in additional inputs of metals from shoreline erosion of historical mining deposits and would result in a slight dilution of inputs of sediment and metals relative to existing and future No-Action conditions. The potential for additional inputs of metals would be substantially reduced or eliminated by Mitigation Measure WQ-6 (CP1). Changes in Sacramento River flows can be best characterized as a small decrease in monthly average winter and early spring flows in some years as measured below Keswick Dam, RBPP, Wilkins Slough, and Freeport, and a slight increase in summer flows in most years. This redistribution of flows would have little effect on water quality as measured by metals, sediment, salinity, and temperature.

The small reduction in winter flows caused by CP1 would slightly reduce potential sediment loading and discharge rates, and would also slightly reduce transport of heavy metals. Therefore, the water quality impact of CP1 related to metals and sediment would not be adverse.

Monthly mean water temperatures at all modeling locations (below Shasta Dam, below Keswick Dam, above Bend Bridge, and above Red Bluff) within the upper Sacramento River under CP1 would be essentially equivalent or slightly decreased (i.e., beneficial). Therefore, the effects of CP1 on water quality measured as water temperature would be beneficial, not adverse.

Implementing Mitigation Measure WQ-1 (CP1) would substantially reduce adverse effects from CP1, and the incremental contribution of CP1 to cumulative effects on water quality would no longer be cumulatively considerable. In summary, effects of CP1 on water quality measured as water temperature, metals, and sediment would be less than significant, and CP1 would not cause an incremental cumulatively considerable contribution to an overall significant cumulative impact on water quality in the primary study area.

In the extended study area, CP1 could also influence water quality in the Delta by altering the quality, volume, or timing of Sacramento River flows. However, because changes in Sacramento River flows relative to the No-Action Alternative would be minimal and effects would diminish with distance from Shasta Dam, the effects would be very minor. Water quality effects are attenuated by multiple factors, including flow from tributaries, stormwater runoff, and municipal and agricultural discharges. Furthermore, the Central Valley's reservoirs and diversions are managed as a single integrated system, and the opearional requirements for this system and have been designed to maintain standards for Delta inflow and water quality. Therefore, water quality impacts of CP1 at the Delta would not make a cumulatively considerable incremental contribution to the overall significant cumulative impact on Delta water quality.

As stated previously, effects of climate change on operations of Shasta Lake could include increased inflows and releases at certain times of the year, and decreased releases with potentially increased water temperatures at other times. The additional storage associated with CP1 could potentially reduce these effects, allowing Shasta Lake to capture some of the increased runoff in the winter and early spring for both cold-water storage and release in summer and fall. This would benefit both Sacramento River water temperatures and Delta water quality. Potential impacts associated with Sacramento River water temperatures and Delta water quality would be less than significant under CP1. Therefore, even with the addition of anticipated effects of climate change, CP1 would not have a significant cumulative effect, and could be potentially beneficial.

CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

The cumulative effects of CP2 would be similar to those of CP1, except that the greater increase in reservoir storage and river flow alteration under CP2 would result in greater beneficial effects on water temperature in the upper Sacramento River. Effects on sediments and metals in the Upper Sacramento River, and on Delta water quality, would be effectively the same as CP1. Therefore, water quality impacts of CP2 would not make a cumulatively considerable incremental contribution to the overall significant cumulative water quality impact in the primary study area or extended study area, including the Delta.

As stated previously, effects of climate change on operations of Shasta Lake could include increased inflows and releases at certain times of the year, and decreased releases with potentially increased water temperatures at other times. The additional storage associated with CP2 could potentially reduce these effects, allowing Shasta Lake to capture some of the increased runoff in the winter and early spring for both cold-water storage and release in summer and fall. This would benefit both Sacramento River water temperatures and Delta water quality. Potential impacts associated with Sacramento River water temperatures and Delta water quality would be less than significant under CP2. Therefore, even with the addition of anticipated effects of climate change, CP2 would not have a significant cumulative effect, and could be potentially beneficial.

CP3 – 18.5-Foot Dam Raise, Agricultural Water Supply Reliability and Anadromous Fish Survival

The cumulative effects of CP3 would be similar to those of CP1 and CP2, except that the greater increase in reservoir storage and river flow alteration under CP3 would result in greater beneficial effects on water temperature in the upper Sacramento River. Effects on sediments and metals in the upper Sacramento River, and on Delta water quality, would be effectively the same as CP1. Therefore, water quality impacts of CP3 would not make a cumulatively considerable incremental contribution to the overall significant cumulative water quality impact in the primary study area or extended study area, including the Delta.

As stated previously, effects of climate change on operations of Shasta Lake could include increased inflows and releases at certain times of the year, and decreased releases with potentially increased water temperatures at other times. The additional storage associated with CP3 could potentially reduce these effects, allowing Shasta Lake to capture some of the increased runoff in the winter and early spring for both cold-water storage and release in summer and fall. This would benefit both Sacramento River water temperatures and Delta water quality. Potential impacts associated with Sacramento River water temperatures and Delta water quality would be less than significant under CP3. Therefore, even with the addition of anticipated effects of climate change, CP3 would not have a significant cumulative effect, and could be potentially beneficial.

CP4 or CP4A – 18.5-Foot Dam Raise, Anadromous Fish Focus with Water Supply Reliability

With the exception of water quality measured as water temperature, the cumulative effects of CP4 or CP4A would be the same as those of CP1 or CP2. Effects of CP4 or CP4A on water quality measured as water temperature would be beneficial and greater than those of other alternatives. Therefore, water quality impacts of CP4 or CP4A would not make a cumulatively considerable incremental contribution to the overall significant cumulative water quality impact in the primary study area or extended study area, including the Delta.

As stated previously, effects of climate change on operations of Shasta Lake could include increased inflows and releases at certain times of the year, and decreased releases with potentially increased water temperatures at other times. The additional storage associated with CP4 or CP4A could potentially reduce these effects, allowing Shasta Lake to capture some of the increased runoff in the winter and early spring for both cold-water storage and release in summer and fall. This would benefit both Sacramento River water temperatures and Delta water quality. Potential impacts associated with Sacramento River water temperatures and Delta water quality would be less than significant under CP4 or CP4A. Therefore, even with the addition of anticipated effects of climate change, CP4 or CP4A would not have a significant cumulative effect, and could be potentially beneficial.

CP5 – 18.5-Foot Dam Raise, Combination Plan

With the exception of water quality measured as water temperature, the cumulative effects of CP5 would be the same as those of CP1. Effects of CP5 on water quality measured as water temperature would be beneficial and effectively the same as CP3. Therefore, water quality impacts of CP5 would not make a cumulatively considerable incremental contribution to the overall significant cumulative water quality impact in the primary study area or extended study area, including the Delta.

As stated previously, effects of climate change on operations of Shasta Lake could include increased inflows and releases at certain times of the year, and decreased releases with potentially increased water temperatures at other times. The additional storage associated with CP5 could potentially reduce these effects, allowing Shasta Lake to capture some of the increased runoff in the winter and early spring for both cold-water storage and release in summer and fall. This would benefit both Sacramento River water temperatures and Delta water quality. Potential impacts associated with Sacramento River water temperatures and Delta water quality would be less than significant under CP5. Therefore, even with the addition of anticipated effects of climate change, CP5 would not have a significant cumulative effect, and could be potentially beneficial.

This page left blank intentionally.

Chapter 8
Noise and Vibration

8.1 Affected Environment

This section describes the affected environment related to noise and vibration for the dam and reservoir modifications proposed under SLWRI action alternatives.

8.1.1 Acoustic Fundamentals

Noise is generally defined as sound that is loud, disagreeable, or unexpected. Sound, as described in more detail below, is an audible vibration of an elastic medium.

Sound Properties

A sound wave is introduced into a medium (e.g., air) by a vibrating object. The vibrating object (e.g., vocal cords, the string and sound board of a guitar, or the diaphragm of a radio speaker) is the source of the disturbance that sets the medium to vibrate and then propagates through the medium. Regardless of the type of source creating the sound wave, the particles of the medium through which the sound moves are vibrating in a back-and-forth motion at a given frequency, tone, or pitch. The frequency of a wave refers to how often the particles vibrate when a wave passes through the medium. Wave frequency is measured as the number of complete back-and-forth vibrations of a particle per unit of time. If a particle of air undergoes 1,000 longitudinal vibrations in 2 seconds, then the frequency of the wave would be 500 vibrations per second. A commonly used unit for frequency is Hertz (Hz).

Each particle vibrates as a result of the motion of its nearest neighbor. For example, the first particle of the medium begins vibrating at 500 Hz and sets the second particle of the medium into motion at the same frequency (500 Hz). The second particle begins vibrating at 500 Hz and thus sets the third particle into motion at 500 Hz. The process continues throughout the medium; hence each particle vibrates at the same frequency, which is the frequency of the original source. Subsequently, a guitar string vibrating at 500 Hz will set the air particles in the room vibrating at the same frequency (500 Hz), which carries a sound signal to the ear of a listener that is detected as a 500 Hz sound wave.

The back-and-forth vibration motion of the particles of the medium would not be the only observable phenomenon occurring at a given frequency. Because a sound wave is a pressure wave, a detector could be used to detect oscillations in pressure from high to low and back to high pressure. As the compression (high-pressure points) and rarefaction (low-pressure points) disturbances move through the medium, they would reach the detector at a given frequency. For example, a compression would reach the detector 500 times per second if the frequency of the wave were 500 Hz. Similarly, a rarefaction would reach the detector 500 times per second if the frequency of the wave were 500 Hz. Thus, the frequency of a sound wave refers not only to the number of back-and-forth vibrations of the particles per unit of time but also to the number of compression or rarefaction disturbances that pass a given point per unit of time. A detector could be used to detect the frequency of these pressure oscillations over a given period of time. The period of the sound wave can be found by measuring the time between successive compressions or the time between successive rarefactions. The frequency is simply the reciprocal of the period; thus an inverse relationship exists so that as frequency increases, the period decreases, and vice versa.

A wave is a disturbance through some medium (e.g., air, water, space) that typically transfers energy. Waves travel and transfer energy from one point to another, often with little or no permanent displacement of the particles of the medium. For example, in an ocean wave, the seawater appears to be move along the path of the wave. However, the water particles themselves are nearly stationary—it is the energy transferred through those particles (the wave) causing displacement that makes it appear that the water itself is moving.

In the case of sound (and noise), the “wave” is a vibration or disturbance moving through air particles and, at a certain range of frequencies, is audible to the human ear. The amount of energy carried by a wave is related to the amplitude (loudness) of the wave. A high-energy wave is characterized by high amplitude; a low-energy wave is characterized by low amplitude. The amplitude of a wave refers to the maximum amount of displacement of a particle from its rest position. The energy transported by a wave is directly proportional to the square of the amplitude of the wave. This means that a doubling of the amplitude of a wave indicates a quadrupling of the energy transported by the wave.

Sound and the Human Ear

Because of the ability of the human ear to detect a wide range of sound-pressure fluctuations, sound-pressure levels are expressed in logarithmic units called decibels (dB). The sound-pressure level in decibels is calculated by taking the log of the ratio between the actual sound pressure and the reference sound pressure squared. The reference sound pressure is considered the absolute hearing threshold (Caltrans 1998). Use of this logarithmic scale reveals that the total sound from two individual sources of 65 A-weighted decibels (dBA) each (see explanation of the A-weighting scale below) is 68 dBA, not 130 dBA; that is, doubling the source strength increases the sound pressure by 3 dBA.

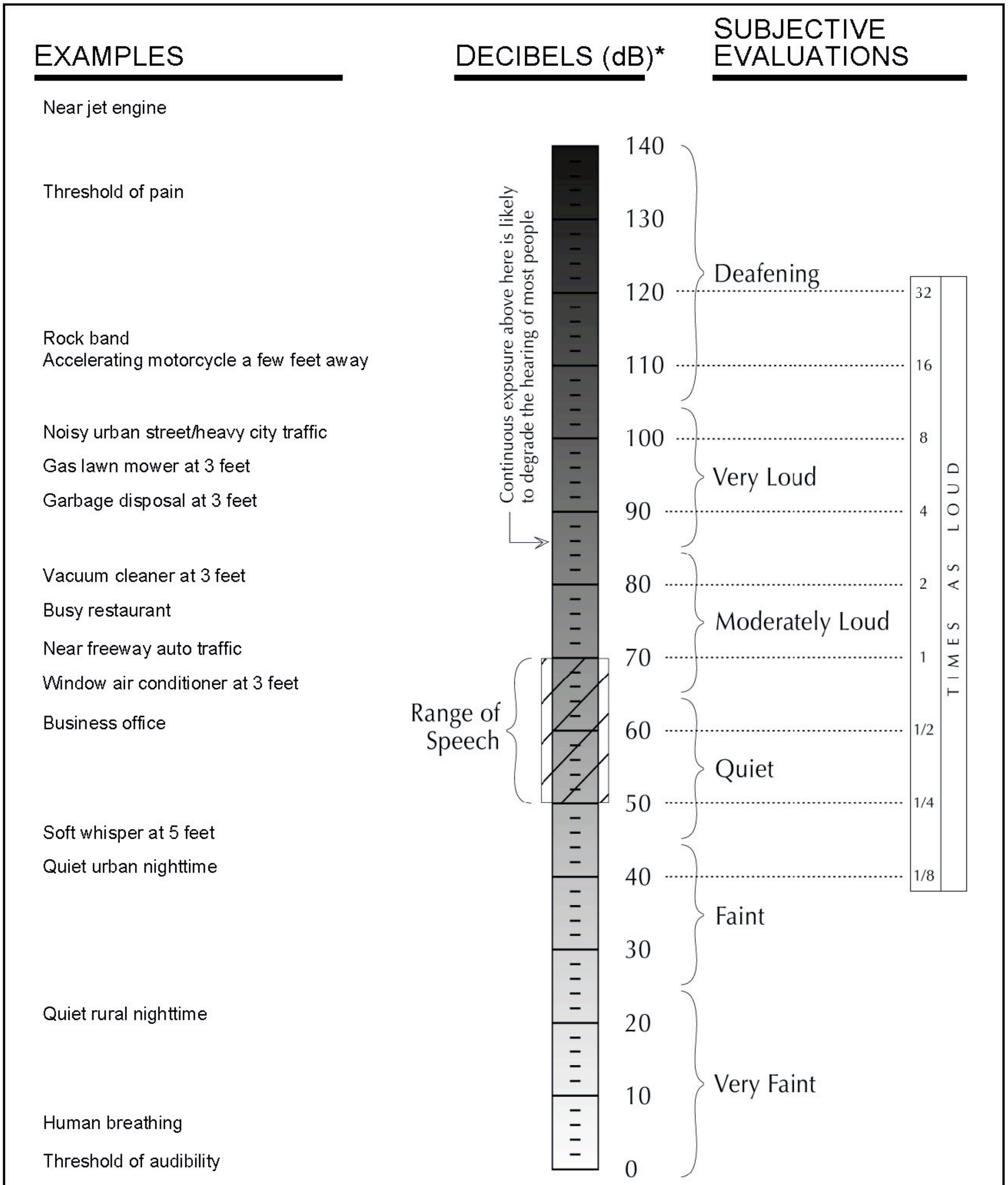
The human ear is sensitive to frequencies from 20 Hz to 20,000 Hz (the audible range) and can detect the vibration amplitudes that are comparable in size to a hydrogen atom (EPA 1974). When damaged by noise, the ear is typically affected at the 4,000-Hz frequency first; therefore, this can be considered the most noise-sensitive frequency. The averaged frequencies of 500 Hz, 1,000 Hz, and 2,000 Hz have traditionally been employed in hearing conservation criteria because of their importance to the hearing of speech sounds (ASA 1997).

The human ear is not equally sensitive to all sound frequencies, depending on the amplitude of the sound; therefore, a specific frequency-dependent rating scale was devised to relate noise to human sensitivity. This called the weighting scale or function. The A-weighting scale is the most commonly used and is noted as A-weighted dB, dB(A), or dBA. The dBA scale discriminates against frequencies in a manner approximating the sensitivity of the human ear when a source is at 50 dB. The basis for compensation is a comparison of the "loudness" of tones played one at a time with a reference tone producing 50 dB. This dBA scale has been chosen by most authorities for the purpose of regulating environmental noise. Typical indoor and outdoor noise levels are presented on Figure 8-1.

With respect to how humans perceive increases in noise levels, for pure tones or some broadband tones, a 1-dBA increase is imperceptible, a 3-dBA increase is barely perceptible, a 6-dBA increase is clearly perceptible, and a 10-dBA increase is subjectively perceived as approximately twice as loud (Egan 1988). For this reason, an increase of 3 dBA or more is generally considered a degradation of the existing noise environment for this type of source. For more complex sources, that is, where the tones differ substantially between sources, such as for the sound of a heavy truck versus a new car or a kitchen blender, the ear perceives differences much more quickly.

Sound Propagation

As sound (noise) propagates from the source to the receptor, the attenuation, or manner of noise reduction in relation to distance, depends on surface characteristics, atmospheric conditions, and the presence of physical barriers. The inverse-square law describes the attenuation when sound travels from a point source such as an air-conditioning unit to the receptor. Sound travels uniformly outward from a point source in a spherical pattern with an attenuation rate of 6 dBA per doubling of distance (dBA/DD). However, from a line source, such as a long line of traffic on a freeway, sound travels uniformly outward in a cylindrical pattern with an attenuation rate of 3 dBA/DD. The surface characteristics between the source and the receptor may result in additional sound absorption and/or reflection. Atmospheric conditions such as wind speed, temperature, and humidity may affect noise levels. Furthermore, the presence of a barrier between the source and the receptor may also attenuate noise levels. The actual amount of attenuation depends on the size of the barrier and the frequency of the noise. A noise barrier may be any natural or human-made feature such as a hill, building, wall, or berm (Caltrans 1998).



* dB are "average" values as measured on the A-scale of a sound-level meter.
From Concepts in Architectural Acoustics: M. David Egan, McGraw Hill, 1972 and U.S. Department of Housing and Urban Development, Office of Community Planning and Development "The Noise Guidebook."

Figure 8-1. Typical Noise Levels

Noise Descriptors

The selection of a proper noise descriptor for a specific source depends on the spatial and temporal distribution, duration, and fluctuation of the noise. The noise descriptors most often encountered when dealing with traffic, community, and environmental noise are defined below (Caltrans 1998; Lipscomb and Taylor 1978):

- **L_{max} (maximum noise level) –** The maximum noise level during a specific period of time. The L_{max} may also be referred to as the "highest (noise) level."
- **L_{min} (minimum noise level) –** The minimum noise level during a specific period of time.
- **L_x (statistical descriptor) –** The noise level exceeded X percent of a specific period of time.
- **L_{eq} (equivalent noise level) –** The energy mean (average) noise level. The instantaneous noise levels during a specific period of time in dBA are converted to relative energy values. From the sum of the relative energy values, an average energy value is calculated, which is then converted back to dBA to determine the L_{eq}.
- **L_{dn} (day-night noise level) –** The 24-hour L_{eq} with a 10-dBA "penalty" for the noise-sensitive hours between 10 p.m. and 7 a.m. The L_{dn} attempts to account for the fact that noise during this specific period of time is a potential source of disturbance with respect to normal sleeping hours.
- **CNEL (community noise equivalent level) –** A noise level similar to the L_{dn} described above, but with an additional 5-dBA "penalty" for the noise-sensitive hours between 7 p.m. and 10 p.m., which are typically reserved for relaxation, conversation, reading, and television. If the same 24-hour noise data are used, the CNEL is typically approximately 0.5 dBA higher than the L_{dn}.
- **SEL (single-event (impulsive) noise level) –** A receiver's cumulative noise exposure from a single impulsive-noise event, which is defined as an acoustical event of short duration and which involves a change in sound pressure above some reference value.

Negative Effects of Noise on Humans

Negative effects of noise exposure include physical damage to the human auditory system, speech interference, sleep interference, activity interference, and disease. Exposure to noise may result in physical damage to the auditory system, which may lead to gradual or traumatic hearing loss. Gradual hearing loss is caused by sustained exposure to moderately high noise levels over a period of time; traumatic hearing loss is caused by sudden exposure to extremely high noise levels over a short period. However, gradual and traumatic hearing loss both may result in permanent hearing damage. In addition, noise may interfere with or interrupt sleep, relaxation, recreation, and communication. Although most interference may be classified as annoying, the inability to hear a warning signal may be considered dangerous. Noise may also be a contributor to diseases associated with stress, such as hypertension, anxiety, and heart disease. The degree to which noise contributes to such diseases depends on the frequency, bandwidth, and level of the noise, and the exposure time (Caltrans 1998).

Vibration Fundamentals

Vibration is sound radiated through the ground. The rumbling sound caused by the vibration of room surfaces is called groundborne noise. Sources of groundborne vibrations include natural phenomena (e.g., earthquakes, volcanic eruptions, sea waves, and landslides) and human-made causes (e.g., explosions, machinery, traffic, trains, and construction equipment). Vibration sources may be continuous, such as factory machinery, or transient, such as explosions. As is the case with airborne sound, groundborne vibrations may be described by amplitude and frequency.

Vibration amplitudes are usually expressed in peak particle velocity (PPV) or root mean squared (RMS), as in RMS vibration velocity. The PPV and RMS velocity are normally described in inches per second (in/sec). PPV is defined as the maximum instantaneous positive or negative peak of a vibration signal. PPV is often used in monitoring of blasting vibration because it is related to the stresses that are experienced by buildings (FTA 2006; Caltrans 2002a).

Although PPV is appropriate for evaluating the potential for building damage, it is not always suitable for evaluating human response. It takes some time for the human body to respond to vibration signals. In a sense, the human body responds to average vibration amplitude. The RMS of a signal is the average of the squared amplitude of the signal, typically calculated over a 1-second period. As with airborne sound, the RMS velocity is often expressed in decibel notation, expressed as vibration decibels (VdB), which serves to compress the range of numbers required to describe vibration (FTA 2006).

The background vibration-velocity level in residential areas is usually approximately 50 VdB. Groundborne vibration is normally perceptible to humans at approximately 65 VdB. For most people, a vibration-velocity level of 75 VdB is the approximate dividing line between barely perceptible and distinctly perceptible levels (FTA 2006).

Typical outdoor sources of perceptible groundborne vibration are construction equipment, steel-wheeled trains, and traffic on rough roads. If a roadway is smooth, the groundborne vibration is rarely perceptible. The range of interest is from approximately 50 VdB, which is the typical background vibration-velocity level, to 100 VdB, which is the general threshold where minor damage can occur in fragile buildings. Construction activities can generate groundborne vibrations, which can pose a risk to nearby structures. Constant or transient vibrations can weaken structures, crack facades, and disturb occupants (FTA 2006).

Construction vibrations can be transient, random, or continuous. Transient construction vibrations are generated by blasting, impact pile driving, and wrecking balls. Continuous vibrations result from vibratory pile drivers, large pumps, and compressors. Random vibration can result from jackhammers, pavement breakers, and heavy construction equipment. Table 8-1 describes the general human response to different levels of groundborne vibration-velocity levels.

Table 8-1. Human Response to Different Levels of Groundborne Noise and Vibration

Vibration-Velocity Level	Human Reaction
65 VdB	Approximate threshold of perception.
75 VdB	Approximate dividing line between barely perceptible and distinctly perceptible. Many people find that transportation-related vibration at this level is unacceptable.
85 VdB	Vibration acceptable only if there are an infrequent number of events per day.

Source: FTA 2006

Key:
VdB = vibration decibels

8.1.2 Existing Noise Sources and Levels

Shasta Lake and Vicinity and Upper Sacramento River (Shasta Dam to Red Bluff)

Existing sources of noise and vibration in the primary study area associated with roadway traffic and aircraft noise are outlined below. Noise is also generated by watercraft on Shasta Lake and stationary noise sources such as mechanical equipment at the existing dam facility. Additional sites that would be affected by the project are existing bridges, roads, and structures that would be inundated with implementation of the proposed dam rise and would need to be modified, demolished, or reconstructed. Sensitive receptors in these areas consist of residences, transient lodging, and recreational facilities.

Roadway Traffic Interstate 5 (I-5) and State Routes 36, 44, 151, 273, and 299 contribute the majority of roadway noise in the greater Shasta area. The Federal Highway Administration’s Highway Traffic Noise Prediction Model was used to predict existing traffic noise levels for these routes. Table 8-2 shows existing average daily traffic volumes for Shasta County’s major roadways, modeled vehicle distribution characteristics, and the modeled distance from the roadway centerline to the various noise-level contours for each affected roadway segment in the study area under existing conditions. The modeling presented was based on 2006 traffic data from California Department of Transportation (Caltrans). These data are also representative of current information from Caltrans (Caltrans 2012) that show minor fluctuations in overall traffic volumes. The traffic noise levels shown in the table assume no shielding or reflection from structures or topography. Actual noise levels would vary from day to day.

Railway traffic in Shasta County is served by the Union Pacific Railroad single-track main line, which travels north/south through the primary study area, paralleling I-5. (The McCloud Railway Company, a single-track short line, runs from McCloud to Burney, but because its activity is limited, noise measurements were not conducted for this line.) Noise measurements were conducted at two sites near Redding and Cottonwood for the *Shasta County General Plan* Noise Element. Table 8-3 presents noise levels associated with railroad noise in the Shasta Lake area.

Aircraft The three existing airports in the primary study area are described below.

Redding Municipal Airport In the 12-month period ending April 2012, there were approximately 104,674 total aircraft operations at Redding Municipal Airport (FAA 2012). As shown in the background report for the *Shasta County General Plan* Noise Element, the 65-dB CNEL contour is confined primarily to the airport property. The 60-dB CNEL contour extends outside of the property, but does not encroach on existing residential uses. According to the *Redding Municipal Airport Master Plan*, aviation growth at the airport will affect the surrounding area. The total number of aircraft operations is estimated to increase to 162,400 by 2015.

Fall River Mills Airport In 2001, there were approximately 6,000 total aircraft operations at Fall River Mills Airport. Based on the *Environmental Assessment for the Fall River Mills Airport Layout Plan* (April 2003), the existing 65-dB CNEL contour is contained within the existing airport boundary. Aviation growth at Fall River Mills Airport can also affect the area surrounding the airport. The number of aircraft operations is expected to increase to 15,000 by 2021. The future (2021) 65-dB CNEL contour is confined to Public Facility and Agriculture lands. The 60-dB CNEL contour also encompasses Urban Residential lands.

Table 8-2. Summary of Modeled Existing Traffic Noise Levels (Year 2006)[1]

Roadway Segment	Modeling Assumptions				Distance (feet) from Roadway Edge to CNEL/L_{dn} (dBA)[1]				CNEL/L_{dn} (dBA) from Roadway Edge
	Average Daily Traffic Volume	Speed (mph)	Traffic Distribution Percentages (%)		70 CNEL	65 CNEL	60 CNEL	55 CNEL	50 Feet
			Auto/Medium Truck/Heavy Truck	Day/ Evening/ Night					
SR 36, north of Red Bluff	12,000	45	79/9/12	79/11/10	64	138	298	641	72
SR 44, junction with I-5	51,000	65	81/9/10	79/11/10	235	507	1,093	2354	80
SR 151, Shasta Lake	5,500	45	81/9/10	79/11/10	36	77	165	356	68
SR 273, Redding	23,800	35	81/9/10	79/11/10	74	160	345	742	73
SR 299, Redding	19,900	35	81/9/10	79/11/10	66	142	306	659	72
I-5, Bridgebay	27,500	70	81/9/10	79/11/10	171	368	792	1,706	78
I-5, Shasta Lake	37,000	70	81/9/10	79/11/10	208	448	965	2,080	79
I-5, Redding	67,000	70	81/9/10	79/11/10	309	666	1,434	3,090	82
I-5, Anderson	50,000	70	81/9/10	79/11/10	254	548	1,180	2,542	81
I-5, Cottonwood	46,500	70	81/9/10	79/11/10	242	522	1,124	2,422	80
I-5, Red Bluff	40,500	70	79/9/12	79/11/10	231	498	1,073	2,313	80

Source: Average daily traffic volumes from CalTrans (2006). Modeling performed by EDAW (now AECOM) in 2007

Note:

[1a] 2006 and 2012 traffic volumes modeled on these roadways produce the same levels of noise.

Key:

% = percent
Caltrans = California Department of Transportation
CNEL = community noise equivalent level
dBA = A-weighted decibels
I-5 = Interstate 5
L_{dn} = day-night noise level
mph = miles per hour
SR = State Route

Table 8-3. Approximate Distance to Union Pacific Railroad Noise Contours

L_{dn}, Based on Distance from Railroad Tracks				Distance to L_{dn} Contour (feet)			
At 50 Feet		At 100 Feet		60 dB		65 dB	
Existing	Future	Existing	Future	Existing	Future	Existing	Future
South of Bonnyview Road				South of Bonnyview Road			
69.5 dB	70.8 dB	65.0 dB	66.3 dB	215	262	100	122
Cottonwood				Cottonwood			
76.0 dB	77.3 dB	71.5 dB	72.8 dB	580	711	269	330

Source: Shasta County 2004

Key:
dB = decibel
L_{dn} = day-night noise level

Benton Airpark In the 12-month period ending December 2011, there were approximately 35,000 total aircraft operations at this Airpark (FAA 2012). Based on the *Benton Airpark Master Plan* (March 2005), the existing 65-dB CNEL contour is contained within the existing airport boundary. Aviation growth at Benton Airpark can also affect the area surrounding the airport. The number of aircraft operations is expected to increase to 38,000 by 2021. The future (2021) 65-dB CNEL contour is confined to airport property and vacant land.

Other Aircraft Activities In addition to the aircraft facilities listed above, helipads from medical facilities in Redding are also in use. Usage of these helipads would be reserved for emergencies and would be intermittent in comparison to usage by full-time facilities such as the Benton Airpark. In the fire season, aircraft, operated by the California Department of Forestry and Fire Protection or under contract with the USFS, use Shasta Lake as a source of water for fighting wildfires. Fire helicopters and tankers use the lake as needed during emergencies. Because firefighting is intermittent, no consistent noise levels would result from firefighting operations.

Fixed Noise Sources Industrial, light industrial, commercial, and public service facilities that could produce objectionable noise levels at nearby noise-sensitive uses are dispersed throughout the primary study area. Among these fixed noise sources are lumber mills, auto maintenance shops, car washes, loading docks, recycling centers, electricity generating stations, landfills, and athletic fields.

Lower Sacramento River and Delta and CVP/SWP Service Areas

Noise sources within the extended study area would be similar to the general descriptions provided for the primary study area.

8.1.3 Existing Noise-Sensitive Land Uses

Shasta Lake and Vicinity and Upper Sacramento River (Shasta Dam to Red Bluff)

Noise-sensitive land uses (sensitive receptors) are uses where exposure to noise would result in adverse effects and uses where quiet is essential. Residential dwellings are of primary concern. Other noise-sensitive land uses are schools, hospitals, convalescent facilities, parks, hotels, places of worship, and libraries. No sensitive land uses are immediately adjacent to (within 0.5 mile of) the dam. Sensitive land uses in the proximity of the dam raise site would be the vacant on site residence at the fish hatchery approximately one-half mile downstream. The nearest occupied residence is the horse camp located approximately 7,000 feet downstream; residents on Lake Boulevard are located approximately 4,500 feet east. Other sensitive receptors would include any residences within one-half mile of other construction work being done as a result of the dam raise. Bridge construction would occur at Charlie Creek, Doney Creek, McCloud River, Pit River, Fenders Ferry, Didallas Creek, and other Union Pacific Railroad bridges. Major road construction would occur on Lakeshore Drive, in the Turntable Bay Area, on Gillman Road, in Jones Valley and the Silverthorn Area, and on Salt Creek Road. The nearest school to construction activities would be the Smithson School in Lakehead (approximately 500 feet); the nearest place of worship would be Canyon Community Church also in Lakehead (approximately 800 feet).

Lower Sacramento River and Delta and CVP/SWP Service Areas

Noise receptors within the extended study area would be similar to those generally described above for the primary study area.

8.2 Regulatory Framework

8.2.1 Federal

No Federal plans, policies, regulations, or laws related to noise are applicable to the project. The environmental review of Federal projects generally defers to State of California (State), county, or other local guidelines.

To address the human response to groundborne vibration, the Federal Transit Administration (FTA) of the U.S. Department of Transportation has set forth guidelines for maximum-acceptable vibration criteria for different types of land uses. These criteria include 65 VdB for land uses where low ambient vibration is essential for interior operations (e.g., hospitals, high-tech manufacturing, and laboratory facilities), 80 VdB for residential uses and buildings where people normally sleep, and 83 VdB for institutional land uses with primarily daytime operations (e.g., schools, churches, clinics, and offices) (FTA 2006).

Standards have also been established to address the potential for groundborne vibration to cause structural damage to buildings. These standards were developed by the Committee of Hearing, Bio Acoustics, and Bio Mechanics at the request of the U.S. Environmental Protection Agency (FTA 2006). For fragile structures, Committee of Hearing, Bio Acoustics, and Bio Mechanics recommends a maximum limit of 0.25 in/sec PPV (FTA 2006).

8.2.2 State

Governor's Office of Planning and Research

The Governor's Office of Planning and Research published the *State of California General Plan Guidelines* (OPR 2003), which provides guidance for the acceptability of projects within specific L_{dn} contours. Table 8-4 summarizes acceptable and unacceptable community noise exposure limits for various land use categories.

Generally, residential uses (e.g., mobile homes) are considered to be acceptable in areas where exterior noise levels do not exceed 60 dBA L_{dn}. Residential uses are normally unacceptable in areas exceeding 70 dBA L_{dn} and conditionally acceptable within 55–70 dBA L_{dn}. Schools are normally acceptable in areas up to 70 dBA L_{dn} and normally unacceptable in areas exceeding 70 dBA L_{dn}. Commercial uses are normally acceptable in areas up to 70 dBA CNEL. Between 67.5 and 77.5 dBA L_{dn}, commercial uses are conditionally acceptable, depending on the noise insulation features and the noise reduction requirements. With respect to water recreation uses, exterior noise levels that do not exceed 75 dBA CNEL/L_{dn} are considered normally acceptable, levels between 70 and 80 dBA CNEL/L_{dn} are normally unacceptable, and levels that exceed 80 dBA CNEL/L_{dn} are clearly unacceptable. The guidelines also present adjustment factors that may be used to arrive at noise-acceptability standards that reflect the noise-control goals of the community, the particular community's sensitivity to noise, and the community's assessment of the relative importance of noise issues.

California Department of Transportation

For the protection of fragile, historic, and residential structures, Caltrans recommends a threshold of 0.2 in/sec PPV for normal residential buildings and 0.08 in/sec PPV for old or historically significant structures (Caltrans 2002a). These standards are more stringent than the Federal standard established by Committee of Hearing, Bio Acoustics, and Bio Mechanics, presented above.

Table 8-4. State Noise-Compatibility Guidelines by Land-Use Category

Land-Use Category	Community Noise Exposure (CNEL/L_{dn}, dBA)			
	Normally Acceptable [1]	Conditionally Acceptable [2]	Normally Unacceptable [3]	Clearly Unacceptable [4]
Residential – Low-Density Single-Family, Duplexes, Mobile Homes	< 60	55–70	70–75	75+
Residential – Multifamily	< 65	60–70	70–75	75+
Transient Lodging – Motels, Hotels	< 65	60–70	70–80	80+
Schools, Libraries, Churches, Hospitals, Nursing Homes	< 70	60–70	70–80	80+
Auditoriums, Concert Halls, Amphitheaters		< 70	65+	
Sports Arenas, Outdoor Spectator Sports		< 75	70+	
Playgrounds, Neighborhood Parks	< 70		68–75	72.5+
Golf Courses, Riding Stables, Water Recreation, Cemeteries	< 75		70–80	80+
Office Buildings, Businesses, Commercial and Professional	< 70	68–78	75+	
Industrial, Manufacturing, Utilities, Agriculture	< 75	70–80	75+	

Source: OPR 2003

Notes:

[1] Specified land use is satisfactory, based on the assumption that any buildings involved are of normal conventional construction, without any special noise-insulation requirements.

[2] New construction or development should be undertaken only after a detailed analysis of the noise-reduction requirements is made and needed noise-insulation features are included in the design. Conventional construction, but with closed windows and fresh-air supply systems or air conditioning, will normally suffice.

[3] New construction or development should generally be discouraged. If new construction or development does proceed, a detailed analysis of the noise-reduction requirements must be made and needed noise-insulation features included in the design. Outdoor areas must be shielded.

[4] New construction or development should generally not be undertaken.

Key:
< = less than
+ = and greater
CNEL = community noise equivalent level
dBA = A-weighted decibels
L_{dn} = day-night noise level

8.2.3 Regional and Local

All major project-related construction activities would occur in Shasta County. However, haul trucks and employee trips could also occur in Tehama County and, thus, related information is also provided. In any note, the regulations provided are very similar for both.

Shasta County

Shasta County General Plan Noise Element The Noise Element of the *Shasta County General Plan* includes goals, standards, and policies designed to ensure that county residents are not subjected to noise beyond acceptable levels (Shasta County 2004). Policies that may be applicable to the project include the following:

- **Policy N-b –** Noise likely to be created by a proposed non-transportation land use shall be mitigated so as not to exceed the noise level standards of Table 8-5 as measured immediately within the property line of adjacent lands designated as noise-sensitive.

- **Policy N-c –** Where proposed non-residential land uses are likely to produce noise levels exceeding the performance standards of Table 8-5 upon existing or planned noise-sensitive uses, an acoustical analysis shall be required as part of the environmental review process so that appropriate noise mitigation may be included in the project design. The requirements for the content of an acoustical analysis are given by Table 8-5.

- **Policy N-d –** The feasibility of proposed projects with respect to existing and future transportation noise levels shall be evaluated by comparison to Tables 8-5 and 8-6.

- **Policy N-f –** Noise created by new transportation sources shall be mitigated to satisfy the levels specified in Table 8-5 at outdoor activity areas and/or interior spaces of existing noise-sensitive land uses. Transportation noise shall be compared with existing and projected noise levels.

- **Policy N-g –** Existing noise-sensitive uses may be exposed to increased noise levels due to future roadway improvement projects as a result of increased traffic capacity and volumes and increases in travel speeds. In these instances, it may not be practical to reduce increased traffic noise levels consistent with those contained in Table 8-5. Therefore, as an alternative, the following criteria may be used as a test of significance for increases in the ambient outdoor activity areas of the noise level of noise-sensitive uses created as a result of a new roadway improvement project:

  – Where existing traffic noise levels are less than 60 dB Ldn, a +5 dB Ldn increase will be considered significant,

– Where existing traffic noise levels range between 60 and 65 dB Ldn, a +3 dB Ldn increase will be considered significant, and

– Where existing traffic noise levels are greater than 65 dB Ldn, a + 1.5 dB Ldn increase will be considered significant.

Table 8-5. Noise Level Performance Standards for New Projects Affected by or Including Nontransportation Sources

Noise Level Descriptor	Daytime (7 a.m. to 10 p.m.)	Nighttime (10 p.m. to 7 a.m.)
Hourly L_{eq}, dB	55	50

The noise levels specified above shall be lowered by 5 dB for simple tone noises, noises consisting primarily of speech or music, or for recurring impulsive noises. These noise level standards do not apply to residential units established in conjunction with industrial or commercial uses (e.g., caretaker dwellings).

The County can impose noise level standards which are more restrictive than those specified above based upon determination of existing low ambient noise levels.

In rural areas where large lots exist, the exterior noise level standard shall be applied at a point 100 feet away from the residence.

Industrial, light industrial, commercial, and public service facilities which have the potential for producing objectionable noise levels at nearby noise-sensitive uses are dispersed throughout the County. Fixed-noise sources which are typically of concern include, but are not limited to, the following:

HVAC Systems	Heavy Equipment
Cooling Towers/Evaporative Condensers	Conveyor Systems
Pump Stations	Transformers
Lift Stations	Pile Drivers
Emergency Generators	Grinders
Boilers	Drill Rigs
Steam Valves	Gas or Diesel Motors
Steam Turbines	Welders
Generators	Cutting Equipment
Fans	Outdoor Speakers
Air Compressors	Blowers

Source: Shasta County 2004

Notes:

The types of uses which may typically produce the noise sources described above include, but are not limited to: industrial facilities including lumber mills, trucking operations, tire shops, auto maintenance shops, metal fabricating shops, shopping centers, drive-up windows, car washes, loading docks, public works projects, batch plants, bottling and canning plants, recycling centers, electric generating stations, race tracks, landfills, sand and gravel operations, and athletic fields.

For the purposes of the Noise Element, transportation noise sources are defined as traffic on public roadways, railroad line operations, and aircraft in flight. Control of noise from these sources is preempted by Federal and State regulations. Other noise sources are presumed to be subject to local regulations, such as a noise control ordinance. Non-transportation noise sources may include industrial operations, outdoor recreation facilities, heating, ventilation, and air conditioning units, loading docks, etc.

Key:
County = Shasta County
dB = decibels
HVAC = heating, ventilation, and air conditioning
L_{eq} = equivalent noise level

Table 8-6. Requirements for an Acoustical Analysis

An acoustical analysis prepared pursuant to the Noise Element shall:
A. Be the financial responsibility of the applicant.
B. Be prepared by a qualified person experienced in the fields of environmental noise assessment and architectural acoustics.
C. Include representative noise level measurements with sufficient sampling periods and locations to adequately describe local conditions and the predominant noise sources.
D. Estimate existing and projected cumulative (20 years) noise levels in terms of L_{dn} or CNEL and/or the standards of Table [8-5], and compare those levels to the adopted policies of the Noise Element.
E. Recommend appropriate mitigation to achieve compliance with the adopted policies and standards of the Noise Element, giving preference to proper site planning and design over mitigation measures which require the construction of noise barriers or structural modifications to buildings which contain noise-sensitive land uses.
F. Estimate noise exposure after the prescribed mitigation measures have been implemented.
G. Describe a post-project assessment program which could be used to evaluate the effectiveness of the proposed mitigation measures.

Source: Shasta County 2004
Key:
CNEL = community noise equivalent level
L_{dn} = day-night noise level

- **Policy N-i –** Where noise mitigation measures are required to achieve the standards of Tables 8-5 and 8-6, the emphasis of such measures shall be placed upon site planning and project design. The use of noise barriers shall be considered a means of achieving compliance with the noise standards only after all other practical design-related noise mitigation measures have been integrated into the project.

- **Policy N-j –** Encourage railroad officials to install noise-mitigation features on trains, equipment, and at fixed-based facilities whenever possible, and instruct railroad engineers to limit their use of air horns to reduce rail-related noise impacts on cities, towns, and rural community centers.

- **Policy N-k –** All County airports lacking adopted noise level contours consistent with the General Plan forecast year of 2025 should update their respective Master Plans or Comprehensive Land Use Plans to reflect aircraft operation noise levels for existing and future operations.

- **Policy N-l –** The use of site planning and building materials/design as primary methods of noise attenuation is encouraged.

- **Policy N-m –** The County should adopt noise control guidelines to assist staff and project applicants in determining the appropriate methods for reducing transportation and non-transportation generated noise.

- **Policy N-n –** The State Noise Insulation Standards (California Code of Regulations, Title 24) and Chapter 35 of the Uniform Building Code shall be enforced.

- **Policy N-o** – As the County updates the geographic information system (GIS) mapping data base, the traffic, airport, and railroad noise contour information contained within the Background Report for the Noise Element shall be included as a part of the mapping data base. Noise contours for transportation and fixed noise sources should be periodically updated and any subsequent revisions of the data shall be incorporated into the General Plan and adopted for noise control planning purposes, as appropriate (see Tables 8-7 and 8-8).

Table 8-7. Maximum Allowable Noise Exposure Transportation Noise Sources

Land Use	Outdoor Activity Areas[1] L_{dn}/CNEL, dB	Interior Spaces	
		L_{dn}/CNEL, dB	L_{eq}, dB[2]
Residential	60 [3]	45	–
Transient Lodging	60 [4]	45	–
Hospitals, Nursing Homes	60 [3]	45	–
Theaters, Auditoriums, Music Halls	–	–	35
Churches, Meeting Halls	60 [3]	–	40
Office Buildings	–	–	45
Schools, Libraries, Museums	–	–	45
Playgrounds, Neighborhood Parks	70	–	–

Source: Shasta County 2004

Notes:

[1] Where the location of outdoor activity areas is unknown, the exterior noise level standard shall be applied to the property line of the receiving land use. Where it is not practical to mitigate exterior noise levels at patio or balconies of apartment complexes, a common area such as a pool or recreation area may be designated as the outdoor activity area.

[2] As determined for a typical worst-case hour during periods of use.

[3] Where it is not possible to reduce noise in outdoor activity areas to 60 dB L_{dn}/CNEL or less using a practical application of the best-available noise reduction measures, exterior noise levels of up to 65 dB L_{dn}/CNEL may be allowed provided that available exterior noise level reduction measures have been implemented and interior noise levels are in compliance with this table.

[4] In the case of hotel/motel facilities or other transient lodging, outdoor activity areas such as pool areas may not be included in the project design. In these cases, only the interior noise level criterion will apply.

Key:

CNEL = community noise equivalent level

dB = decibels

L_{dn} = day-night noise level

Table 8-8. Transportation Noise–Related Land Use Compatibility Guidelines for Development in Shasta County

Land Use Category	Community Noise Exposure (L_{dn} or CNEL, dB)							
		55	60	65	70	75	80	
Residential, Theaters, Music and Meeting Halls, Churches, and Auditoriums	G.A.	X	X					
	C.A.			X	X			
	G.U.					X	X	X
Transient Lodging— Motels, Hotels, and RV Parks	G.A.	X	X					
	C.A.			X	X	X		
	G.U.						X	X
Schools, Libraries, Museums, Nursing Homes, and Child Care	G.A.	X	X					
	C.A.			X	X	X		
	G.U.						X	X
Playgrounds, Neighborhood Parks, and Amphitheaters	G.A.	X	X	X	X			
	C.A.					X		
	G.U.						X	X
Office Buildings, Business, Commercial, and Professional	G.A.	X	X	X				
	C.A.				X	X		
	G.U.						X	X
Industrial, Manufacturing, Agriculture, and Utilities	G.A.	X	X	X	X			
	C.A.					X	X	X
	G.U.							
Golf Courses, Outdoor Spectator Sports, and Riding Stables	G.A.	X	X	X	X			
	C.A.					X	X	
	G.U.							X

Source: Shasta County 2004

Key:

CNEL = community noise equivalent level

dB = decibels

G.A. = Generally Acceptable. Specified land use is satisfactory. No noise mitigation measures are required.

C.A. = Conditionally Acceptable. Use should be permitted only after careful study and inclusion of protective measures as needed to satisfy the policies of the Noise Element.

G.U. = Generally Unacceptable. Development is usually not feasible in accordance with the goals of the Noise Element.

L_{dn} = day-night noise level

Shasta County Code The Shasta County Code has one provision related to noise:

> *13.04.170: Unnecessary Noise Prohibited. No person shall operate any aircraft in flight or on the ground in such a manner as to cause unnecessary noise as determined by applicable Federal or State or local laws and regulations. (Prior code Section 2112.)*

Tehama County

Tehama County General Plan The Noise Element of the *Tehama County General Plan* provides a basis for comprehensive local policies to control and abate environmental noise and to protect the citizens of the county from excessive noise exposure (Tehama County 2009). The fundamental goals of the Noise Element are as follows:

- **Goal N-1 –** Provide sufficient information concerning the community noise environment so that noise may be effectively considered in the land use planning process.

  – **Policy N-1.1 –** The County shall require an acoustical analysis for new projects anticipated to generate excessive noise located adjacent, or near, to noise-sensitive land uses. The acoustical analysis shall be prepared in accordance with Table 8-9, Requirements for Acoustical Analysis Prepared in Tehama County.

Table 8-9. Requirements for an Acoustical Analysis Prepared In Tehama County

An acoustical analysis prepared pursuant to the Noise Element shall:	
(1)	Be the responsibility of the applicant.
(2)	Be prepared by qualified persons experienced in the fields of environmental noise assessment and architectural acoustics.
(3)	Include representative noise level measurements with sufficient sampling periods and locations to adequately describe local conditions.
(4)	Estimate existing and projected cumulative noise levels in terms of the standards of Tables 9-6 and 9-7 of this General Plan and compare those levels to the adopted policies of the Noise Element.
(5)	Recommend appropriate mitigation to achieve compliance with the adopted policies and standards of the Noise Element. Where the noise source in question consists of intermittent single events, the report must address the effects of maximum noise levels in sleeping rooms evaluating possible sleep disturbance.
(6)	Estimate interior and exterior noise exposure after the prescribed mitigation measures have been implemented.
(7)	Describe the post-project assessment program that could be used to evaluate the effectiveness of the proposed mitigation measures.

Source: Tehama County 2009

- **Goal N-2 –** Develop strategies for abating excessive noise exposure through cost-effective mitigation measures in combination with appropriate zoning to avoid incompatible land uses.

  – **Policy N-2.4 –** The County shall restrict construction activities to the hours as determined in the Countywide Noise Control Ordinance, if such an Ordinance is adopted.

    ▪ **Implementation Measure N-2.4a –** Restrict construction activities to the hours as determined by the County's Noise Control Ordinance unless an exemption is received from the County to cover special circumstances. Special circumstances may include emergency operations, short-duration construction, etc.

    ▪ **Implementation Measure N-2.4b –** Require all internal combustion engines that are used in conjunction with construction activities be muffled according to the equipment manufacturer's requirements.

- **Goal N-3 –** Protect those existing regions of the planning area whose noise environments are deemed acceptable, and also those locations throughout the community deemed "noise sensitive."

- **Goal N-4 –** Protect existing noise-producing commercial and industrial uses in Tehama County from encroachment by noise-sensitive land uses.

  - **Policy N-4.1 –** The County shall require review for discretionary industrial, commercial, or other noise-generating land uses for compatibility with adjacent and nearby noise-sensitive land uses.

  - **Policy N-4.2 –** The interior and exterior noise level standards for noise-sensitive areas of new uses affected by non-transportation noise sources within Tehama County are depicted in Table 8-10.

Lower Sacramento River and Delta

General plan noise elements and noise ordinances from all counties in the lower Sacramento River and Delta and communities in Tehama, Butte, Glenn, Colusa, Sutter, Yolo, Sacramento, Solano, and Contra Costa counties would be applicable to affected areas within their jurisdictions. The general plans and codes in these jurisdictions would be similar to the Shasta and Tehama county regulations outlined above. Construction, land use, and acceptable levels for various land uses would be defined and outlined.

CVP/SWP Service Areas

All community and county plans and ordinances in the CVP and SWP service areas would be applicable to affected areas within their jurisdictions. The general plans and codes in these jurisdictions would be similar to the Shasta and Tehama county regulations outlined above. Construction, land use, and acceptable levels for various land uses would be defined and outlined.

Table 8-10. Noise Standards for New Uses Affected By Nontransportation Noise in Tehama County

New Land Use	Outdoor Activity Area—L_{eq}, dB		Interior—L_{eq}, dB	
	Daytime	Nighttime	Day and Night	Notes
All Residential	50	45	35	a, b, g
Transient Lodging	55	–	40	c
Hospitals and Nursing Homes	50	45	35	d
Theaters and Auditoriums	–	–	35	
Churches, Meeting Halls, Schools, Libraries, etc.	55	–	40	
Office Buildings	55	–	45	e, f
Commercial Buildings	55	–	45	e, f
Playgrounds, Parks, etc.	65	–	–	f
Industry	65	65	50	e

Source: Tehama County 2009

Notes:

[a] Outdoor activity areas for single-family residential uses are defined as back yards. For large parcels or residences with no clearly defined outdoor activity area, the standard shall be applicable within a 100-foot radius of the residence.

[b] For multi-family residential uses, the exterior noise level standard shall be applied at the common outdoor recreation area, such as at pools, play areas or tennis courts. Where such areas are not provided, the standards shall be applied at individual patios and balconies of the development.

[c] Outdoor activity areas of transient lodging facilities include swimming pool and picnic areas, and are not commonly used during nighttime hours.

[d] Hospitals are often noise generating uses. The exterior noise level standards for hospitals are applicable only at clearly identified areas designated for outdoor relaxation by either hospital staff or patients.

[e] Only the exterior spaces of these uses designated for employee or customer relaxation have any degree of sensitivity to noise.

[f] The outdoor activity areas of office, commercial and park uses are not typically used during nighttime hours.

[g] It may not be possible to achieve compliance with this standard at residential uses located immediately adjacent to loading dock areas of commercial uses while trucks are unloading. The daytime and nighttime noise level standards applicable to loading docks shall be 55 and 50 dB Leq, respectively.

General: The Table 9-7 standards shall be reduced by 5 dB for sounds consisting primarily of speech or music, and for recurring impulsive sounds. If the existing ambient noise level exceeds the standards of Table 9-7, then the noise level standards shall be increased at 5 dB increments to encompass the ambient.

Key:
dB = decibels
L_{eq} = equivalent noise level

8.3 Environmental Consequences and Mitigation Measures

8.3.1 Methods and Assumptions

Land use types and major noise sources in the project vicinity were identified based on existing documentation (e.g., the Shasta County Zoning Code) and site reconnaissance data. To assess potential short-term construction noise impacts, sensitive receptors and their relative exposure (considering topographic barriers and distance) were identified. Noise levels of specific construction equipment were determined and resultant noise levels at those receptors were calculated.

Potential long-term (operational) traffic, area-source, and stationary-source noise impacts were qualitatively assessed based on the number of vehicle trips and other potential operational noise sources introduced to the project area.

Groundborne vibration impacts were qualitatively assessed based on existing documentation (e.g., vibration levels produced by specific construction equipment) and the distance of sensitive receptors from the given source.

Predicted noise levels were compared with applicable standards for determination of significance. Mitigation measures were developed for significant and potentially significant noise impacts.

8.3.2 Criteria for Determining Significance of Effects

An environmental document prepared to comply with NEPA must consider the context and intensity of the environmental effects that would be caused by, or result from, the proposed action. Under NEPA, the significance of an effect is used solely to determine whether an EIS must be prepared. An environmental document prepared to comply with CEQA must identify the potentially significant environmental effects of a proposed project. A "[s]ignificant effect on the environment" means a substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by the project" (State CEQA Guidelines, Section 15382). CEQA also requires that the environmental document propose feasible measures to avoid or substantially reduce significant environmental effects (State CEQA Guidelines, Section 15126.4(a)).

The following significance criteria were developed based on guidance provided by the State CEQA Guidelines, other Federal, State, and local guidance, and consider the context and intensity of the environmental effects as required under NEPA. Impacts of an alternative on noise would be significant if project implementation would do any of the following:

- Expose persons to or generate noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies.

- Expose persons to or generate excessive groundborne vibration or groundborne noise levels.

- Permanently increase ambient noise levels in the project vicinity substantially above levels existing without the project.

- Temporarily or periodically increase ambient noise levels in the project vicinity substantially above levels existing without the project.

- Expose people residing or working in the project area to excessive aircraft-generated noise levels.

8.3.3 Topics Eliminated from Further Consideration

None of the project alternatives would expose people residing or working in the project area to excessive aircraft-generated noise levels because of the distance of existing airports to the project area. In addition, none of the alternatives would place new sensitive receptors near any aircraft-related facilities. There would also be no change in railway traffic as a result of any of the alternatives. Therefore, potential effects on the primary and extended study areas related to these issues are not discussed further in this EIS.

This analysis assumes that the operation of any of the project alternatives would not generate any new significant long-term noise sources because operation and maintenance of Shasta Dam and current or relocated recreational facilities would be relatively unchanged compared to existing conditions. Relocated recreational facilities would presumably generate the same levels and types of noise, but in a slightly different location than currently exists. After completion of the dam raise, bridge and levee construction, and relocation of recreational facilities, the number of personnel serving at all sites during construction would be reduced to approximately the number currently serving to operate and maintain the facilities. Therefore, no further analysis is needed and these issues are not discussed further in this EIS.

No effects on the current ambient noise environment would occur in the lower Sacramento River and Delta and the CVP and SWP service areas; no construction activities would occur in these geographic regions, and there would be no long-term noise sources from dam operation, modified flows in the Sacramento River and other tributaries, or water storage and conveyance throughout the CVP and SWP service areas. Therefore, potential effects related to project noise in those geographic regions are not discussed further in this EIS.

8.3.4 Direct and Indirect Effects

No-Action Alternative

Shasta Lake and Vicinity and Upper Sacramento River (Shasta Dam to Red Bluff)

Impact Noise-1 (No-Action): Exposure of Sensitive Receptors in the Primary Study Area to Project-Generated Construction Noise No construction activities would occur and current operations would continue. Recreational use, population, and traffic would all increase but these increases and the effect on the noise environment would not be substantial. This impact would be less than significant.

No construction activities would occur and the dam would continue to function as it currently functions. Because no construction activities would occur under this alternative, implementation of the No-Action Alternative would not contribute toward a temporary change in the ambient noise environment. Generally, ambient noise levels could likely increase under the No-Action Alternative because greater recreational use, population growth, and traffic would occur; however, these increases would not be substantial. As a result, this impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Impact Noise-2 (No-Action): Exposure of Sensitive Receptors in the Primary Study Area to Project-Generated Vibration During Construction No construction activities would occur and current operations would continue. Recreational use, population, and traffic could increase, but such source types are not considered to be major vibration sources. This impact would be less than significant.

This impact is similar to Impact Noise-1 (No-Action) for the primary study area. For the same reasons as described under Impact Noise-1 (No-Action), this impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Impact Noise-3 (No-Action): Exposure of Sensitive Receptors in the Primary Study Area to Project-Generated Mobile-Source Noise During Operations No construction activities would occur and current operations would continue. Recreational use, population, and traffic would all increase, but these increases and the effect on the noise environment would not be substantial. This impact would be less than significant.

This impact is similar to Impact Noise-1 (No-Action) for the primary study area. For the same reasons as described under Impact Noise-1 (No-Action), this impact would be less than significant.

Lower Sacramento River and Delta and CVP/SWP Service Areas No effects related to noise and vibration are expected to occur in the lower Sacramento River and Delta and the CVP/SWP service areas; therefore, potential effects in those geographic regions are not discussed further in this EIS.

CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

Shasta Lake and Vicinity and Upper Sacramento River (Shasta Dam to Red Bluff)

Impact Noise-1 (CP1): Exposure of Sensitive Receptors in the Primary Study Area to Project-Generated Construction Noise Temporary construction noise from activities at Shasta Dam, including site preparation (e.g., excavation, grading, and clearing), raising, tree removal, material handling, blasting, demolition, site restoration and cleanup, would not exceed applicable noise-level standards at nearby noise-sensitive receptors. Increases in truck traffic from construction would also not cause a perceptible increase in current traffic noise levels or a noticeable difference in ambient noise levels. However, related activities at other construction sites (e.g., bridges, roads, recreation facilities) could result in noise levels that exceed applicable standards resulting in substantial increases at nearby sensitive receptors. This temporary impact would be significant.

Construction activities at the Shasta Dam site under CP1 would include site preparation (e.g., excavation, grading, and clearing), the proposed dam raise, blasting, tree removal, material handling, site restoration and clean-up, and other miscellaneous activities. Temporary noise effects of the operation of heavy-duty construction equipment at the dam, blasting activities, operation of heavy-duty construction equipment at other project sites, and off-site construction traffic are addressed separately below.

Operation of Heavy-Duty Construction Equipment at the Dam The construction activities mentioned above would require the use of scrapers, excavators, bulldozers, compactors, loaders, trucks, crushers, pumps, pavers, concrete mixers, cranes, generators, and other miscellaneous pieces of equipment based on similar projects. According to the U.S. Environmental Protection Agency, noise levels generated by individual pieces of these types of equipment can range from 76 to 94 dBA at 50 feet without feasible noise control (Table 8-11). Simultaneous operation of the heavy-duty construction equipment could result in combined intermittent noise levels of approximately 94 dBA at 50 feet from the project site. Based on these noise levels and a typical noise-attenuation rate of 6.0 dBA/DD, exterior noise levels at noise-sensitive receptors located within 4,000 feet of construction activity could exceed 55 dBA Leq (the Shasta County standard for daytime hours) without noise control. However, there is a 450-foot elevation increase spanning 4,500 feet of intervening topography between the nearest receptors (residences on Lake Boulevard) and Shasta Dam. Accounting for the intervening topography attenuation, the vegetation, and the distance between the dam and receptors, an attenuation rate of approximately -100 dBA can be applied (-40 dBA for distance, -10 dBA for trees and vegetation, and -50 dBA for topographic elevation change). Thus, noise levels at the nearest sensitive receptor would be less than 50 dBA L_{dn}.

Table 8-11. Typical Construction Equipment Noise Levels

Type of Equipment	Noise Level at 50 feet (dBA)
Scraper	89
Excavator	89
Bulldozer	85
Compactor	82
Loader	85
Truck	88
Crusher	94
Pump	76
Paver	89
Concrete Pump	82
Concrete Mixer	85
Derrick Crane	88
Pile Driving (sonic)	96
Generator	81

Source: FTA 2006

Key:
dBA = A-weighted decibels

Additional residential receptors are approximately 7,000 feet down the Sacramento River from Shasta Dam. The construction-related noise level at this location would be approximately 45 dBA (95 dBA at 50 feet from construction site minus 45 dBA attenuation for distance, and minus 5 dBA attenuation from vegetation and topography). Thus, project construction noise generated by on-site construction equipment at Shasta Dam under CP1 would not expose sensitive receptors to or generate noise levels in excess of applicable standards (55 dBA daytime, 50 dBA nighttime), or to a substantial temporary increase in noise levels above existing conditions.

Blasting Activities at the Dam Construction of the Shasta Dam crest raise increase would require blasting during excavation of rock for the concrete tie-in to adjacent rock. Specific blast design parameters such as explosive type and amount (charge weight), drill pattern, and time scheme are not known at this time. However, it is anticipated that few blasts would occur each day. Blasting operations would result in airborne noise caused by the energy released in the explosion, which creates an air overpressure (airblast) in the form of a propagating wave. Still, as currently planned, SELs could exceed 110 dBA (FTA 2006). However, based on the above attenuation rates (i.e., distance between source and receptors, intervening topography and vegetation) coupled with the intermittent nature of blasting, such activities would not be anticipated to exceed applicable hourly standards.

Operation of Heavy-Duty Construction Equipment at Other Project Sites Multiple construction activities would occur at the other project-related sites (Pit River Bridge, the lakeshore area, and other areas where bridges and roads would require relocation; recreation facilities that would require removal and reconstruction; and inundation areas that would require clearing). Among the anticipated construction activities are site preparation (e.g., excavation, grading, demolition, and clearing), paving, pile driving, laying of railroad tracks, bridge relocation, removal of trees and vegetation, material handling, and site restoration and cleanup.

Based on similar projects, the on-site construction equipment required for the activities would likely include but not be limited to an excavator, bulldozer, front-end loader, grader, compactor, cranes, pile drivers, trucks, and other large pieces of equipment as necessary. According to the U.S. Environmental Protection Agency, noise levels from individual pieces of these types of equipment, when operated without feasible noise control, can range from 79 to 96 dBA at 50 feet (Table 8-11). Simultaneous operation of the three noisiest pieces of heavy-duty construction equipment, including pile driving, could result in combined intermittent noise levels of approximately 97 dBA at 50 feet from the project site. Based on these noise levels and a typical noise-attenuation rate of 6.0 dBA/DD, exterior noise levels at noise-sensitive receptors located within 75 feet of construction activity (i.e., sensitive receptors along Lakeshore Drive) could exceed 94 dBA L_{eq} without noise control. Such noise levels could exceed Shasta County standards (55 dBA daytime, 50 dBA nighttime).

Helicopters would also be used for vegetation removal during the spring and fall, when helicopters are not in use for firefighting. Helicopter noise levels range from 80 to 90 dBA at 250 feet (Caltrans 2002b). Noise levels from helicopters would be similar to those of other construction equipment described above.

Construction in areas away from the dam site would occur primarily during the daytime; however, the exact hours of construction are not specified at this time, nor has Shasta County adopted a noise ordinance that exempts construction noise from the provisions of the standard. If construction activities were to occur during the more noise-sensitive hours (evening, nighttime, and early morning), or if equipment were not properly equipped with noise-control devices, construction noise could exceed applicable noise-level standards (i.e., Shasta County's nighttime standard of 50 dBA L_{eq}) at existing noise-sensitive receptors located within 7,000 feet. In addition, any project-related construction noise generated during these more noise-sensitive hours may annoy and/or disrupt the sleep of occupants of the nearby existing noise-sensitive land uses, and temporarily but substantially increase ambient noise levels in the project vicinity. As a result, this impact would be significant.

Off-Site Construction Traffic Project construction would require approximately 350 on-site employees at any given time. Assuming two total trips per day per employee and 81 round trips per day for the transport of equipment and materials, project construction would result in a maximum of approximately 862 one-way daily trips at the dam site. Typically, traffic volumes must double before the associated increase in noise levels is noticeable (3 dBA CNEL/L_{dn}) along roadways. Given that the average daily traffic volumes are 5,500 for State Route 151, 37,000 for I-5, and 2,000 for the Lakeshore Community, traffic would not double. Therefore, adding these daily trips on the local roadway system to existing volumes would be a minor change. Consequently, project construction under CP1 would not noticeably change the traffic-noise contours of area roadways.

Summary Implementing CP1 would not result in noise levels that exceed applicable standards related to operation of heavy-duty construction equipment and blasting at Shasta Dam and off-site construction traffic. However, the impact of this alternative related to the operation of heavy-duty construction equipment at other project sites would be significant. Mitigation for this impact is proposed in Section 8.3.5.

Impact Noise-2 (CP1): Exposure of Sensitive Receptors in the Primary Study Area to Project-Generated Vibration During Construction Temporary construction-related activities would not expose persons to or generate excessive groundborne vibration or groundborne noise. As a result, this temporary impact would be less than significant.

According to FTA, vibration levels associated with the use of trucks, dozers, and other heavy-duty construction equipment such as the equipment types used at project construction sites are 0.076 to 0.089 in/sec PPV and 86–87 VdB at 25 feet, and vibration levels from pile driving can reach 0.73 in/sec PPV (Table 8-10). Vibration levels generated during project construction under CP1 could exceed Caltrans's recommended standard with respect to the prevention of structural damage (0.2 in/sec PPV for buildings) and FTA's maximum-acceptable constant vibration standard of 80 VdB with respect to human annoyance for residential uses within 65 feet of the impact zone. Because there are no sensitive receptors within these distances from any of the construction sites (the nearest residences would be along Lakeshore Drive and approximately 75 feet from road and bridge construction activities taking place in the area), implementing CP1 would not generate excessive groundborne vibration or groundborne noise levels, nor would it expose persons or buildings to such groundborne vibration or noise. As a result, this temporary impact would be less than significant.

Blasting at the Shasta Dam site would result in ground vibration from the creation of seismic waves that radiate along the earth's surface. As discussed previously, no noise-sensitive receptors are located near the dam site. Receptors would need to be within 250 feet of the blasts to be affected (greater than 80 VdB) by groundborne vibration. No sensitive receptors are within this range of the dam. Therefore, this temporary impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Noise-3 (CP1): Exposure of Sensitive Receptors in the Primary Study Area to Project-Generated Mobile-Source Noise During Operations Traffic associated with project operations would not expose persons to or generate noise in excess of applicable mobile-source noise standards, nor would such traffic noise create a substantial increase in ambient noise levels in the project vicinity. As a result, this impact would be less than significant.

Relocating Lakeshore Drive would move traffic noise closer to sensitive receptors in the Lakeshore Community. Based on roads of this size and service, it is estimated that the maximum average daily traffic in this area would be approximately 2,000 vehicles per day. Modeling by the Federal Highway Administration for a 2,000-average daily traffic two-lane roadway places the 60-dBA L_{dn} contour (Shasta County's transportation standard) at 70 feet from the roadway centerline. With the additional noise emanating from the adjacent railroad line (Shasta County 2004) and the nearest receptors farther than 75 feet from the new roadway centerline, the ambient noise level would not increase by more than 3 dBA or exceed 60 dBA (Shasta County 2004). Thus, project-generated long-term traffic noise would not result in an exceedence of the Shasta County standards. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta and CVP/SWP Service Areas
Implementing CP1 would not generate any new long-term noise outside of the primary study area. Furthermore, no construction work would occur in the extended study area; as a result, no project noise would be temporarily added to the current noise environment. No effects related to noise and vibration are expected to occur in the lower Sacramento River and Delta and the CVP/SWP service areas; therefore, potential effects of CP1 in those geographic regions are not discussed further in this EIS.

CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

The direct and indirect impacts of CP2 related to noise and vibration would be essentially the same as those described for CP1 because construction activities, and equipment and workforce needs, would be similar under both alternatives. Also, the long-term impact of CP2 on traffic levels associated with relocating Lakeshore Drive would be expected to be similar to the corresponding impact of CP1. Thus, as described below, the impacts described for CP1 would generally also apply to CP2.

Shasta Lake and Vicinity and Upper Sacramento River (Shasta Dam to Red Bluff)
Impact Noise-1 (CP2): Exposure of Sensitive Receptors in the Primary Study Area to Project-Generated Construction Noise Temporary construction noise

from activities at Shasta Dam including site preparation (e.g., excavation, grading, and clearing), raising, tree removal, material handling, blasting, demolition, site restoration and cleanup would not exceed applicable noise-level standards at nearby noise-sensitive receptors. Construction activities at Shasta Dam would consist of site preparation (e.g., excavation, grading, and clearing), the dam raise, blasting, tree removal, material handling, demolition, and site restoration and cleanup. Increases in truck traffic from construction would also not cause a perceptible increase in current traffic noise levels or a noticeable difference in ambient noise levels. However, related activities at other construction sites (e.g., bridges, roads, recreation facilities) could result in noise levels that exceed applicable standards resulting in substantial increases at nearby sensitive receptors. This impact would be the same as Impact Noise-1 (CP1) and would be significant. Mitigation for this impact is proposed in Section 8.3.5.

Impact Noise-2 (CP2): Exposure of Sensitive Receptors in the Primary Study Area to Project-Generated Vibration During Construction Temporary construction-related activities would not expose persons to or generate excessive groundborne vibration or groundborne noise. As a result, this impact would be less than significant.

This impact would be the same as Impact Noise-2 (CP1) where no sensitive receptors are within this range of the dam. Therefore, this temporary impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Noise-3 (CP2): Exposure of Sensitive Receptors in the Primary Study Area to Project-Generated Mobile-Source Noise During Operations Traffic associated with project operations would not expose persons to or generate noise in excess of applicable mobile-source noise standards, nor would such traffic create a substantial increase in ambient noise levels in the project vicinity. As a result, this impact would be less than significant.

This impact would be the same as Impact Noise-3 (CP1) where the ambient noise level would not increase by more than 3 dBA or exceed 60 dBA (Shasta County 2004). Thus, project-generated long-term traffic noise would not result in an exceedence of the Shasta County standards. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta and CVP/SWP Service Areas Similar to CP1, implementing CP2 would not generate any new long-term noise outside of the primary study area. Furthermore, no construction work would occur in the extended study area; as a result, no project noise would be temporarily added to the current noise environment. No effects related to noise and vibration are expected to occur in the lower Sacramento River and Delta and the CVP/SWP service areas; therefore, potential effects of CP2 in those geographic regions are not discussed further in this EIS.

CP3 –18.5-Foot Dam Raise, Agricultural Water Supply Reliability with Anadromous Fish Survival

The direct and indirect impacts of CP3 related to noise and vibration would be essentially the same as those described for CP1 and CP2 because construction activities, and equipment and workforce needs, would be similar under these alternatives. Also, the long-term impact of CP3 on traffic levels associated with relocating Lakeshore Drive would be expected to be similar to the corresponding impact of CP1 and CP2. Thus, as described below, the impacts described for CP1 and CP2 would generally also apply to CP3.

Shasta Lake and Vicinity and Upper Sacramento River (Shasta Dam to Red Bluff)

Impact Noise-1 (CP3): Exposure of Sensitive Receptors in the Primary Study Area to Project-Generated Construction Noise Temporary construction noise from activities at Shasta Dam including site preparation (e.g., excavation, grading, and clearing), raising, tree removal, material handling, blasting, demolition, site restoration and cleanup would not exceed applicable noise-level standards at nearby noise-sensitive receptors. Construction activities at Shasta Dam would consist of site preparation (e.g., excavation, grading, and clearing), the dam raise, blasting, tree removal, material handling, demolition, and site restoration and cleanup. Increases in truck traffic from construction would also not cause a perceptible increase in current traffic noise levels or a noticeable difference in ambient noise levels. However, related activities at other construction sites (e.g., bridges, roads, recreation facilities) could result in noise levels that exceed applicable standards resulting in substantial increases at nearby sensitive receptors.

This impact would be the same as Impact Noise-1 (CP1) where implementing CP3 would not result in noise levels that exceed applicable standards related to operation of heavy-duty construction equipment and blasting at Shasta Dam and off-site construction traffic. However, the impact of this alternative related to the operation of heavy-duty construction equipment at other project sites would be significant. Mitigation for this impact is proposed in Section 8.3.5.

Impact Noise-2 (CP3): Exposure of Sensitive Receptors in the Primary Study Area to Project-Generated Vibration During Construction Temporary construction-related activities would not expose persons to or generate excessive groundborne vibration or groundborne noise. As a result, this impact would be less than significant.

This impact would be the same as Impact Noise-2 (CP1) where no sensitive receptors are within this range of the dam. Therefore, this temporary impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Noise-3 (CP3): Exposure of Sensitive Receptors in the Primary Study Area to Project-Generated Mobile-Source Noise During Operations Traffic associated with project operations would not expose persons to or generate noise in excess of applicable mobile-source noise standards, nor would such traffic create a substantial increase in ambient noise levels in the project vicinity. As a result, this impact would be less than significant.

This impact would be the same as Impact Noise-3 (CP1) where the ambient noise level would not increase by more than 3 dBA or exceed 60 dBA (Shasta County 2004). Thus, project-generated long-term traffic noise would not result in an exceedence of the Shasta County standards. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta and CVP/SWP Service Areas Similar to CP1 and CP2, implementing CP3 would not generate any new long-term noise outside of the primary study area. Furthermore, no construction work would occur in the extended study area; as a result, no project noise would be temporarily added to the current noise environment. No effects related to noise and vibration are expected to occur in the lower Sacramento River and Delta and the CVP/SWP service areas; therefore, potential effects of CP3 in those geographic regions are not discussed further in this EIS.

CP4 and CP4A – 18.5-Foot Dam Raise, Anadromous Fish Focus With Water Supply Reliability

The direct and indirect impacts of CP4 or CP4A related to noise and vibration would be essentially the same as those described for CP1 through CP3 because construction activities, and equipment and workforce needs, would be similar under these alternatives. Also, the long-term impact of CP4 or CP4A on traffic levels associated with relocating Lakeshore Drive would be expected to be similar to the corresponding impact of CP1 through CP3. Thus, as described below, the impacts described for CP1 through CP3 would generally also apply to CP4 and CP4A.

Shasta Lake and Vicinity and Upper Sacramento River (Shasta Dam to Red Bluff)

Impact Noise-1 (CP4 and CP4A): Exposure of Sensitive Receptors in the Primary Study Area to Project-Generated Construction Noise Temporary construction noise from activities at Shasta Dam including site preparation (e.g., excavation, grading, and clearing), raising, tree removal, material handling, blasting, demolition, site restoration and cleanup would not exceed applicable noise-level standards at nearby noise-sensitive receptors. Construction activities at Shasta Dam would consist of site preparation (e.g., excavation, grading, and clearing), the dam raise, blasting, tree removal, material handling, demolition, and site restoration and cleanup. Gravel augmentation under CP4 or CP4A would increase the total number of construction-related truck trips, but not enough to result in a violation of traffic noise standards or a substantial increase in traffic noise. However, related activities at other construction sites (e.g., bridges, roads, recreation facilities) could result in noise levels that exceed applicable standards resulting in substantial increases at nearby sensitive receptors. This temporary impact would be significant for CP4 or CP4A.

This impact would be similar to Impact Noise-1 (CP1), but slightly greater because of the addition of gravel augmentation along the upper Sacramento River that is proposed under CP4 and CP4A. The proposed gravel augmentation would result in approximately 800 truck trips per year. Assuming 44 work days, approximately 18 truck trips per day would be added to the local roadway network. In addition, the upper Sacramento River restoration sites would also be included under CP4 and CP4A. Upper Sacramento River restoration site construction would include an excavator, loader, and compaction equipment. Noise levels would be similar to those described under CP1 and CP2 (see Table 8-11). Approximately 350 haul trips would be needed to remove material from the site, resulting in approximately eight trips per day over a 2-month period. As discussed above under Impact Noise-1 (CP1), to generate a substantial increase in traffic noise, the traffic volume must double. Because adding 26 truck trips would not double roadway traffic volumes, no violation of traffic noise standards or substantial increase in traffic noise would occur.

For the same reasons as described for Impact Noise-1 (CP1), this impact would be significant for CP4. Mitigation for this impact is proposed in Section 8.3.5.

For the same reasons as described for Impact Noise-1 (CP1), this impact would be significant for CP4A. Mitigation for this impact is proposed in Section 8.3.5.

Impact Noise-2 (CP4 and CP4A): Exposure of Sensitive Receptors in the Primary Study Area to Project-Generated Vibration During Construction Temporary construction-related activities would not expose persons to or generate excessive groundborne vibration or groundborne noise. As a result, this impact would be less than significant.

This impact would be the same as Impact Noise-2 (CP1) where blasting at the Shasta Dam site would result in ground vibration from the creation of seismic waves that radiate along the earth's surface. As discussed previously, no noise-sensitive receptors are located near the dam site. Receptors would need to be within 250 feet of the blasts to be affected (greater than 80 VdB) by groundborne vibration. No sensitive receptors are within this range of the dam.

Therefore, this temporary impact would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

Therefore, this temporary impact would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact Noise-3 (CP4 and CP4A): Exposure of Sensitive Receptors in the Primary Study Area to Project-Generated Mobile-Source Noise During Operations Traffic associated with project operations would not expose persons to or generate noise in excess of applicable mobile-source noise standards, nor would such traffic create a substantial increase in ambient noise levels in the project vicinity. As a result, this impact would be less than significant for CP4 or CP4A.

This impact would be the same as Impact Noise-3 (CP1) where the ambient noise level would not increase by more than 3 dBA or exceed 60 dBA (Shasta County 2004). Thus, project-generated long-term traffic noise would not result in an exceedence of the Shasta County standards.

This impact would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

This impact would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta and CVP/SWP Service Areas Similar to CP1, the implementation of CP4 or CP4A would not generate any new long-term noise sources outside of the primary study area. Furthermore, no construction work would occur in the extended study area; as a result, no project noise would be temporarily added to the current noise environment. No effects related to noise and vibration are expected to occur in the lower Sacramento River and Delta and the CVP/SWP service areas; therefore, potential effects of CP4 or CP4A in those geographic regions are not discussed further in this EIS.

CP5 – 18.5-Foot Dam Raise, Combination Plan

The direct and indirect impacts of CP5 related to noise and vibration would be essentially the same as those described for CP1 through CP4 because construction activities, and equipment and workforce needs, would be similar under these alternatives. Also, the long-term impact of CP5 on traffic levels associated with relocating Lakeshore Drive would be expected to be similar to the corresponding impact under CP1 and CP2. Thus, as described below, the impacts described for CP1 and CP2 would generally also apply to CP5.

Shasta Lake and Vicinity and Upper Sacramento River (Shasta Dam to Red Bluff)

Impact Noise-1 (CP5): Exposure of Sensitive Receptors in the Primary Study Area to Project-Generated Construction Noise Temporary construction noise from activities at Shasta Dam including site preparation (e.g., excavation, grading, and clearing), raising, tree removal, material handling, blasting, demolition, site restoration and cleanup would not exceed applicable noise-level standards at nearby noise-sensitive receptors. Construction activities at Shasta Dam would consist of site preparation (e.g., excavation, grading, and clearing), the dam raise, blasting, tree removal, material handling, demolition, and site restoration and cleanup. Gravel augmentation under CP5 would increase the total number of construction-related truck trips, but not enough to result in a violation of traffic noise standards or a substantial increase in traffic noise.

However, related activities at other construction sites (e.g., bridges, roads, recreation facilities) could result in noise levels that exceed applicable standards resulting in substantial increases at nearby sensitive receptors. This temporary impact would be significant.

Like CP4 and CP4A, CP5 would involve gravel augmentation and restoration at sites along the upper Sacramento River, neither of which would occur under CP1, CP2, or CP3. Upper Sacramento River restoration site construction would include an excavator, loader, and compaction equipment. Noise levels would be similar to those described under CP1 and CP2 (see Table 8-11). Approximately 350 haul trips would be needed to remove material from the site, resulting in approximately eight trips per day over a 2-month period. As discussed above under Impact Noise-1(CP1), to generate a substantial increase in traffic noise, a doubling of traffic volume would be required. Because adding 26 truck trips would not double roadway traffic volumes, no violation of traffic noise standards or substantial increase in traffic noise would occur. Noise levels from construction equipment, however, would still likely exceed noise standards. Therefore, temporary, construction-related impacts would be significant.

Thus, this impact would be the same as Impact Noise-1 (CP4 and CP4A) and would be significant. Mitigation for this impact is proposed in Section 8.3.5. Increases in truck traffic from construction would also not cause a perceptible increase in current traffic noise levels or a noticeable difference in ambient noise levels. However, related activities at other construction sites (e.g., bridges, roads, recreation facilities) could result in noise levels that exceed applicable standards resulting in substantial increases at nearby sensitive receptors. This temporary impact would be significant.

Impact Noise-2 (CP5): Exposure of Sensitive Receptors in the Primary Study Area to Project-Generated Vibration During Construction Temporary construction-related activities would not expose persons to or generate excessive groundborne vibration or groundborne noise. The additional habitat development included in CP5 would occur in uninhabited areas of Shasta-Trinity National Forest, would not affect sensitive receptors, and would be temporary. As a result, this impact would be less than significant.

This impact would be the same as Impact Noise-2 (CP1). CP5 would also involve development of additional habitat; however, habitat development would occur in an uninhabited area managed by the U.S. Bureau of Land Management, would not be expected to affect any sensitive receptors, and would be temporary. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Noise-3 (CP5): Exposure of Sensitive Receptors in the Primary Study Area to Project-Generated Mobile-Source Noise During Operations Traffic associated with project operations would not expose persons to or generate noise in excess of applicable mobile-source noise standards, nor would such traffic create a substantial increase in ambient noise levels in the project vicinity. The additional habitat development included in CP5 would occur in uninhabited areas of Shasta-Trinity National Forest, would not create new operational traffic, and would not affect sensitive receptors. This impact would be less than significant.

This impact would be the same as Impact Noise-3 (CP1). CP5 would also involve development of additional habitat; however, habitat development would occur in an uninhabited area managed by the U.S. Bureau of Land Management, would not create any new operational traffic, and is not expected to affect any sensitive receptors. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta and CVP/SWP Service Areas Similar to CP1 and CP2, implementing CP5 would not generate any new long-term noise outside of the primary study area. Furthermore, no construction work would occur in the extended study area; as a result, no project noise would be temporarily added to the current noise environment. No effects related to noise and vibration are expected to occur in the lower Sacramento River and Delta and the CVP/SWP service areas; therefore, potential effects of CP5 in those geographic regions are not discussed further in this EIS.

8.3.5 Mitigation Measures

Table 8-12 presents a summary of mitigation measures for noise and vibration.

Table 8-12. Summary of Mitigation Measures for Noise and Vibration

<table>
<tr><th>Impact</th><th></th><th>No-Action Alternative</th><th>CP1</th><th>CP2</th><th>CP3</th><th>CP4/ CP4A</th><th>CP5</th></tr>
<tr><td rowspan="3">Impact Noise-1: Exposure of Sensitive Receptors in the Primary Study Area to Project-Generated Construction Noise</td><td>LOS before Mitigation</td><td>LTS</td><td>S</td><td>S</td><td>S</td><td>S</td><td>S</td></tr>
<tr><td>Mitigation Measure</td><td>None required.</td><td colspan="5">Mitigation Measure Noise-1: Implement Measures to Prevent Exposure of Sensitive Receptors to Temporary Construction Noise at Project Construction Sites.</td></tr>
<tr><td>LOS after Mitigation</td><td>LTS</td><td>LTS</td><td>LTS</td><td>LTS</td><td>LTS</td><td>LTS</td></tr>
<tr><td rowspan="3">Impact Noise-2: Exposure of Sensitive Receptors in the Primary Study Area to Project-Generated Vibration During Construction</td><td>LOS before Mitigation</td><td>LTS</td><td>LTS</td><td>LTS</td><td>LTS</td><td>LTS</td><td>LTS</td></tr>
<tr><td>Mitigation Measure</td><td>None required.</td><td colspan="5">None needed; thus, none proposed.</td></tr>
<tr><td>LOS after Mitigation</td><td>LTS</td><td>LTS</td><td>LTS</td><td>LTS</td><td>LTS</td><td>LTS</td></tr>
</table>

Table 8-12. Summary of Mitigation Measures for Noise and Vibration (contd.)

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/ CP4A	CP5
Impact Noise-3: Exposure of Sensitive Receptors in the Primary Study Area to Project-Generated Mobile-Source Noise During Operations	LOS before Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS

Key:
CP = Comprehensive Plan
LOS = level of significance
LTS = less than significant
S = significant

No-Action Alternative

No mitigation measures are needed for this alternative.

CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

No mitigation is needed for Impacts Noise-2 (CP1) and Noise-3 (CP1). Mitigation is provided below for the remaining noise impact of CP1.

Mitigation Measure Noise-1 (CP1): Implement Measures to Prevent Exposure of Sensitive Receptors to Temporary Construction Noise at Project Construction Sites Reclamation and its primary construction contractors will implement the measures listed below during construction:

- Construction activities producing high impact noise at non-dam sites will be limited to the less noise-sensitive daytime hours and days (7 a.m. to 10 p.m., Monday through Friday). Nighttime (10 p.m. to 7 a.m.) construction activities at non-dam sites noise levels shall not exceed county standards.

- All contractors and subcontractors shall be specific in their contracts and purchase orders for equipment, gravel, aggregate, and other building supplies, as well as for debris removal, that all truck deliveries and debris removal trips that use roadways that pass within 50 feet of inhabitable rooms of residential dwellings shall be limited to the less noise-sensitive daytime hours (7 a.m. to 10 p.m.). Applicable roadways where nighttime truck travel shall be prohibited include the segment of Shasta Dam Boulevard (State Route 151) between Interstate 5 and Lake Boulevard (Road 415) and/or the segments of

Lake Boulevard immediately north and south of Shasta Dam Boulevard.

- All construction equipment and staging areas will be located at the farthest distance feasible from nearby noise-sensitive land uses.
- All construction equipment will be properly maintained and equipped with noise-reduction intake and exhaust mufflers and engine shrouds, in accordance with manufacturers' recommendations. Equipment engine shrouds will be closed during equipment operation.
- All motorized construction equipment will be shut down when not in use to prevent idling.
- A temporary barrier will be placed as close to the noise source or receptor as possible and will break the line of sight between the source and receptor.
- A disturbance coordinator will be designated and the person's telephone number conspicuously posted around the project sites and supplied to nearby residences. The disturbance coordinator will receive all public complaints and be responsible for determining the cause of the complaint and implementing any feasible measures to alleviate the problem.

Implementation of Mitigation Measure Noise-1, as revised above, would reduce temporary project generated construction source noise levels and limit them to the less sensitive daytime hours, thus preventing exposure of sensitive receptors to temporary construction noise at dam and non-dam sites. Implementation of this mitigation measure would also eliminate exposure of off-site residential uses to truck-generated SELs that would cause substantial levels of sleep disturbance. As a result, Impact Noise-1 would be reduced to a less-than-significant level for all the action alternatives.

CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

No mitigation is needed for Impacts Noise-2 (CP2) and Noise-3 (CP2). Mitigation is provided below for the remaining noise impact of CP2.

Mitigation Measure Noise-1 (CP2): Implement Measures to Prevent Exposure of Sensitive Receptors to Temporary Construction Noise at Project Construction Sites This mitigation measure is identical to Mitigation Measure Noise-1 (CP1). Implementation of this mitigation measure would reduce Impact Noise-1 (CP2) to a less-than-significant level.

CP3 – 18.5-Foot Dam Raise, Agricultural Water Supply Reliability with Anadromous Fish Survival

No mitigation is needed for Impacts Noise-2 (CP3) and Noise-3 (CP3). Mitigation is provided below for the remaining noise impact of CP3.

Mitigation Measure Noise-1 (CP3): Implement Measures to Prevent Exposure of Sensitive Receptors to Temporary Construction Noise at Project Construction Sites This mitigation measure is identical to Mitigation Measure Noise-1 (CP1). Implementation of this mitigation measure would reduce Impact Noise-1 (CP3) to a less-than-significant level.

CP4 and CP4A – 18.5-Foot Dam Raise, Anadromous Fish Focus With Water Supply Reliability

No mitigation is needed for Impacts Noise-2 (CP4 and CP4A) and Noise-3 (CP4 and CP4A). Mitigation is provided below for the remaining noise impact of CP4 and CP4A.

Mitigation Measure Noise-1 (CP4 and CP4A): Implement Measures to Prevent Exposure of Sensitive Receptors to Temporary Construction Noise at Project Construction Sites This mitigation measure is identical to Mitigation Measure Noise-1 (CP1). Implementation of this mitigation measure would reduce Impact Noise-1 (CP4 and CP4A) to a less-than-significant level.

CP5 – 18.5-Foot Dam Raise, Combination Plan

No mitigation is needed for Impacts Noise-2 (CP5) and Noise-3 (CP5). Mitigation is provided below for the remaining noise impact of CP5.

Mitigation Measure Noise-1 (CP5): Implement Measures to Prevent Exposure of Sensitive Receptors to Temporary Construction Noise at Project Construction Sites This mitigation measure is identical to Mitigation Measure Noise-1 (CP1). Implementation of this mitigation measure would reduce Impact Noise-1 (CP5) to a less-than-significant level.

8.3.6 Cumulative Effects

Chapter 3, “Considerations for Describing the Affected Environment and Environmental Consequences,” discusses overall cumulative impacts methodology related to the action alternatives, including the relationship to the CALFED Bay-Delta Program Programmatic EIS/EIR cumulative impacts analysis, qualitative and quantitative assessment, past and future actions in the study area, and significance criteria. Table 3-1, “Present and Reasonably Foreseeable Future Actions Included in the Analysis of Cumulative Impacts, by Resource Area,” lists the present and reasonably foreseeable future projects considered quantitatively and qualitatively within the cumulative impacts analysis. This cumulative impacts analysis accounts for potential project impacts combined with the impacts of existing facilities, conditions, land uses, and reasonably foreseeable actions expected to occur in the study area on a qualitative and quantitative level.

Past and present projects within Shasta and Tehama counties have affected noise conditions in the primary study area through the use of heavy construction equipment and the increase in traffic resulting from construction activities. Other transient noise sources (e.g., railroads, traffic on existing highways) also contribute to ambient noise in the primary study area.

The action alternatives would not combine with any of the quantitatively assessed projects listed in Table 3-1 to have a cumulatively considerable impact on noise and vibration; therefore, this section evaluates only those projects listed in Table 3-1 that are qualitatively considered in this EIS.

Shasta Lake and Vicinity and Upper Sacramento River (Shasta Dam to Red Bluff)

Projects that could influence ambient noise levels in areas where the SLWRI could contribute noise include projects listed within the *Shasta-Trinity National Forest Land and Resource Management Plan, Iron Mountain Mine Restoration Plan, and Mendocino National Forest Land and Resource Management Plan;* and construction of the Antlers Bridge replacement. If the listed projects were to occur concurrently with construction of any of the project alternatives under the SLWRI (CP1–CP5), combined noise generation during construction would be unlikely to be substantial because noise is generally a local phenomenon and is minimal beyond 0.5 mile. Noise from SLWRI construction activities would not combine with other noise sources, such as construction from the projects listed above. After project construction is completed, the ambient noise environment relative to SLWRI construction activities would return to existing conditions. Therefore, none of the project alternatives would make a cumulatively considerable incremental contribution to cumulative noise effects.

Lower Sacramento and Delta and CVP/SWP Service Areas

Raising Shasta Dam would not result in any short-term or long-term effects on the ambient noise environment in the extended study area under any of the project alternatives. Therefore, there would be no cumulatively considerable incremental contribution to cumulative noise effects under any of the project alternatives.

Chapter 9
Hazards and Hazardous Materials and Waste

9.1 Affected Environment

This chapter describes the affected environment related to hazards and hazardous materials for the dam and reservoir modifications proposed under SLWRI action alternatives. Because of the potential influence of the proposed modification of Shasta Dam and water deliveries over a rather large geographic area, the SLWRI includes both a primary study area and an extended study area. The primary study area has been further divided into Shasta Lake and vicinity and the upper Sacramento River (Shasta Dam to Red Bluff). The extended study area has been further divided into the lower Sacramento River and Delta and the CVP/SWP service areas.

This section describes hazards and hazardous materials, defined as hazardous waste and hazardous substances, in the primary and extended study areas. The discussion of hazards focuses primarily on wildland fire and its related effects on the human environment and natural resources, and water safety hazards, particularly those related to Shasta Lake. Other relevant hazards, such as flooding, dam failure, and issues related to hydropower generation, public services (e.g., fire protection, law enforcement, emergency services), roadways and bridges, and recreation, are addressed in separate chapters. The effects of proposed fuels treatments, such as pile burning, on air quality are addressed in Chapter 5, "Air Quality and Climate."

The hazards and hazardous waste setting for the primary study area consists of the portion of Shasta County above Shasta Dam and the upper Sacramento River from the dam downstream to the Red Bluff Pumping Plant (RBPP), including the lands within the boundary of the Shasta Unit of the Whiskeytown-Shasta-Trinity National Recreation Area (NRA). This area encompasses parts of the Pit River, Squaw Creek, McCloud River, and Sacramento River watersheds. The hazards and hazardous waste setting for the upper Sacramento River portion of the primary study area consists of lands draining to the Sacramento River between Shasta Dam and Red Bluff.

The hazards and hazardous waste setting for the extended study area includes the Sacramento River basin downstream from the RBPP to the Delta, the Delta itself, the San Joaquin River basin to the Delta, portions of the American River basin, and the CVP/SWP service areas.

9.1.1 Hazards

Shasta Lake and Vicinity

Water Safety Hazards The surface waters of Shasta Lake and, to a lesser extent, Keswick Reservoir and other surface waters in the vicinity pose hazards to persons engaging in boating and other water-based activities (see Chapter 18, “Recreation and Public Access,” for a detailed discussion of water safety hazards related to recreational activities). Water safety hazards are related to equipment operations, flow velocity, morphology, instream or submerged material, accessibility, and water temperature. Working in and adjacent to water bodies also poses risks to workers.

Fluctuations in the reservoir’s pool level affect the pattern of submerged obstacles, which poses a risk to boaters, water skiers, operators of personal watercraft, and workers. Reservoir drawdowns can leave rocks, shoals, and islands submerged below the water surface, where watercraft or skiers can strike them. Conversely, increases in the reservoir’s pool level conceal obstacles beneath the water surface that may be visible one day and submerged the next. Most of these hazards are not marked; however, the USFS public information program warns water-based recreationists via signage and various media to use caution when operating watercraft on the lake.

Although USFS manages Shasta Lake and adjacent Federal lands comprising the NRA’s Shasta Unit, law enforcement and emergency services are provided through a partnership between the Shasta-Trinity National Forest (STNF) and the Shasta County Sheriff’s Office (SCSO) (see Chapter 22, “Public Services,” for a detailed discussion of fire, law enforcement, and emergency services in Shasta Lake and vicinity). SCSO provides safety patrols and emergency response on Shasta Lake and its associated recreational areas and manages a Boating Safety Unit at the Bridge Bay Resort. SCSO staff consists of 4 full-time personnel and 22 seasonal deputies. An organized citizen volunteer patrol also assists with boater safety on Shasta Lake.

Fire Hazards Wildland fires pose a hazard to rural development, infrastructure, and natural resources. Climate, topography, vegetation characteristics, and ignition sources in a given area influence the degree of fire hazard. The California Department of Forestry and Fire Protection (Cal Fire) and STNF have delineated most of the primary study area as being at very high risk for wildland fire; some areas, such as Lakehead, are at extreme risk for fire (Figure 9-1) (Cal Fire 2005, 2008; USFS 1995; WSRCD 2010).

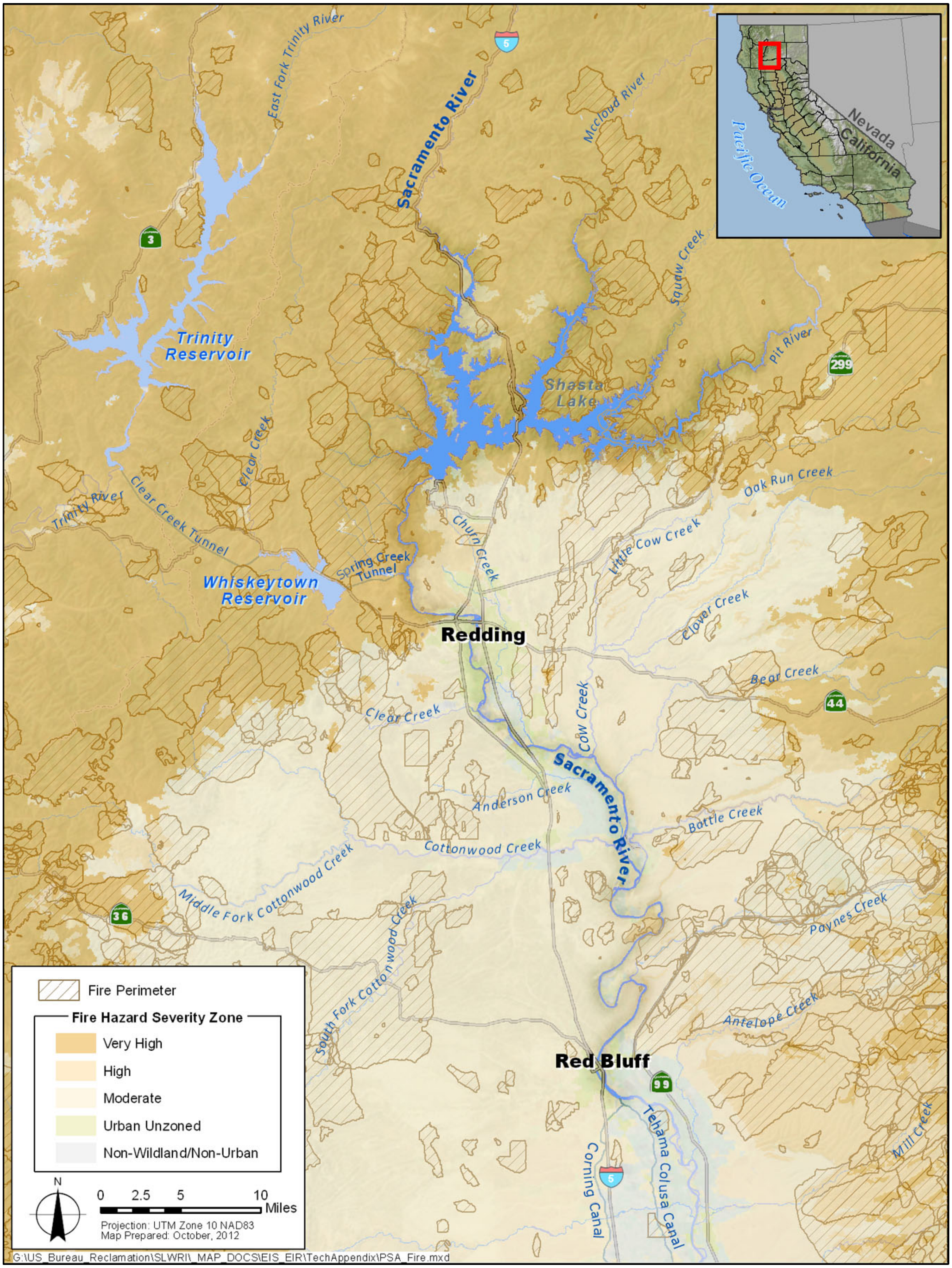


Figure 9-1. Fire Hazard Severity and Historic Fires

Historic fire data show that high-intensity, stand-replacing fires commonly occur at the lower elevations surrounding Shasta Lake. Major transportation corridors cross the NRA and the area receives high recreational use, resulting in numerous human-caused fires each year (USFS 1996). During the 5-year period from 2000 through 2004, the Shasta and Trinity units of the NRA experienced 1,545 vegetation fires affecting 40,352 acres (Cal Fire 2005). Roadside fires, abandoned campfires, and fireworks are common causes of these fires. Lightning from summer thunderstorms also causes a significant number of wildfires in and adjacent to the NRA. Large fires (more than 300 acres) that have occurred in the primary study area since 1950 are shown in Figure 9-1.

Rural and urban development has increasingly influenced the wildland fire hazard potential. Development in grasslands, oak woodlands, and forests (generally referred to as the wildland-urban interface (WUI)) and population growth have increased the risk to humans of wildland fire hazards. Cal Fire and other fire protection agencies expect this trend to continue.

Fire suppression has had a significant effect on the volume and types of fuels across the Shasta Lake region. Extreme fire weather conditions are perpetuated by high summer temperatures and dry lightning storms; particularly along the Sacramento and McCloud arms of Shasta Lake, frequent strong zonal north winds occur during the late summer and fall months. In the past 30 years, the Lakehead area, which is along the Sacramento Arm, has experienced several major fires, including the 1999 High Complex Fire, which was eventually contained at 39,000 acres, and numerous smaller fires that were suppressed in their initial stages (WSRCD 2010).

The concentration of human activity along the McCloud Arm of Shasta Lake prompted STNF to prepare a fire analysis as part of the McCloud Arm Watershed Analysis (USFS 1998). The fire analysis concludes that, at the time it was prepared (1998), more than 17,500 acres of forest surrounding the McCloud Arm was considered at high risk for a catastrophic fire. Cal Fire has designated the fire hazard severity potential in the McCloud Arm as very high (Cal Fire 2008).

The Jones Valley/Silverthorn area adjacent to the Pit Arm of Shasta Lake is another interface area with recognized fire hazards. In the last 12 years, two large fires have greatly affected residential and commercial developments in this area. In 2004, the Bear Fire burned 10,484 acres and destroyed 80 homes in the Jones Valley community, and the 1999 Jones Fire burned 26,020 acres and consumed 900 structures.

Cal Fire has devised a fire hazard severity scale that considers fuel load (vegetation is the major source of fuel), climate, and topography (fire hazards increase with slope) to evaluate the level of wildfire hazard in areas where the State of California (State) is primarily responsible for fire suppression (these are known as State Responsibility Areas). Cal Fire designates three levels of fire hazard severity zones – moderate, high, and very high – to indicate the severity of fire hazard in a particular geographical area. Based on a review of Cal Fire's statewide map of fire hazard severity zones, the primary study area includes lands designated as high and very high (Figure 9-1) (Cal Fire 2007).

Fuels management actions are conducted with some frequency on Federal lands in the Shasta Lake and vicinity portion of the study area. Since 2009, USFS has completed, or is currently proposing, several fuels management projects along the various arms of Shasta Lake, including the Bear Hazardous Fuels Project (Pit Arm), the Green-Horse Habitat Restoration and Maintenance Project (between the Pit and McCloud arms), the Interstate-5 Corridor Fuels Reduction Project (upper Sacramento Arm), and the Packers Bay Invasive Plant Species Removal Project (Sacramento Arm) (USFS 2009, 2011).

Upper Sacramento River (Shasta Dam to Red Bluff)

Water Safety Hazards Water safety hazards in the upper Sacramento River are similar to those in Shasta Lake and vicinity. Surface waters (i.e., Keswick Reservoir and the Sacramento River) pose hazards to persons engaging in boating and other water-based activities on these water bodies. Water hazards are posed by equipment operations, flow velocity, morphology, instream or submerged material, accessibility, and water temperature. Working in and adjacent to water bodies also poses risks to workers.

Fire Hazards Wildland and nonwildland fires present hazard risks to rural and urban development in the upper Sacramento River area. Based on a review of Cal Fire's statewide map of fire hazard severity zones, the upper Sacramento River area includes lands designated as high and very high risk (Figure 9-1) (Cal Fire 2007).

Human activities such as smoking, debris burning, and equipment operation cause 90 percent of the wildland fires in Shasta County, and lightning causes the remaining 10 percent. Wildland fires present a major safety hazard to rural development located in forest, brush, and grass-covered areas. Between 1992 and 2003, an average of 333 wildland fires per year occurred in Shasta County; the majority of these fires were in upland areas, where fire hazards are extreme because of an abundance of highly flammable vegetation and long, dry summers (Shasta County 2004). Large fires (more than 300 acres) that have occurred in the primary study area since 1950, including the upper Sacramento River near Shasta Dam, are shown in Figure 9-1.

Much of Tehama County, outside of the valley floor, is classified as wildland and contains substantial forest fire risks and hazards (Tehama County 2009). Outside of urbanized areas, fire hazard is considered to be moderate (Cal Fire 2007). Encroachment by development into previously uninhabited areas has expanded the WUI, compounding the challenges of wildland fire management. In the portion of the project area that is in Tehama County, no large fires (greater than 300 acres) have occurred in the last 60 years (Figure 9-1) (Cal Fire

2009), because vegetation adjacent to the Sacramento River is not conducive to carrying wildland fire.

Lower Sacramento River and Delta and CVP/SWP Service Areas

Water safety hazards are similar to those described for the primary study area. Fire hazard in the extended study area varies, with risk increasing proportionally with the degree of WUI. As noted previously, Cal Fire maintains a map-based program that identifies fire hazard severity zones throughout the state. The program differentiates between State Responsibility Areas and Local Responsibility Areas. Most of the extended study area is mapped as local (or Federal) responsibility areas with moderate or unzoned fire hazard severity classifications (Cal Fire 2008).

9.1.2 Hazardous Materials and Waste

For purposes of this section, the term “hazardous materials” refers to both hazardous substances and hazardous wastes. A hazardous material is defined in the Code of Federal Regulations (CFR) as “a substance or material that … is capable of posing an unreasonable risk to health, safety, and property when transported in commerce” (49 CFR 171.8). California Health and Safety Code Section 25501 defines a hazardous material as follows:

> *“Hazardous material” means any material that, because of its quantity, concentration, or physical or chemical characteristics, poses a significant present or potential hazard to human health and safety or to the environment if released into the workplace or the environment. “Hazardous materials” include, but are not limited to, hazardous substances, hazardous waste, and any material which a handler or the administering agency has a reasonable basis for believing that it would be injurious to the health and safety of persons or harmful to the environment if released into the workplace or the environment.*

Hazardous wastes are defined in California Health and Safety Code Section 25141(b) as wastes that

> *…because of their quantity, concentration, or physical, chemical, or infectious characteristics, [may either] cause, or significantly contribute to an increase in mortality or an increase in serious illness [or] pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed.*

Potential sources of hazardous materials and wastes may exist in the urbanized, rural, industrial, and agricultural portions of the study areas. Hazardous materials may be present in a variety of common contexts, including the following:

- Construction and demolition debris
- Drums
- Landfills or solid waste disposal sites
- Pits, ponds, or lagoons
- Wastewater and wastewater treatment plants
- Fill, dirt, depressions, and mounds
- Herbicides, pesticides, and fungicides
- Contaminated aggregate (mercury, dioxin)
- Explosives
- Fish hatcheries (e.g., Livingston Stone, Coleman)
- Underground and above ground storage tanks
- Stormwater runoff structures
- Transformers that may contain polychlorinated biphenyls (PCB)
- Utility poles
- Abandoned mines

Shasta Lake and Vicinity

Facilities used to store, generate, and transport hazardous materials and hazardous waste are present upstream from Shasta Dam. In addition, several inactive or abandoned mines contribute hazardous materials to Shasta Lake or its tributaries. The following discussion describes these features and facilities.

Reclamation operates the Shasta Dam facility and controls the use and movement of hazardous materials and associated hazardous waste in and out of the Shasta Dam administrative compound. Operation and maintenance of the dam and the water project facility require the use of many of the hazardous materials listed in the previous section. In addition, utility poles, transformers, and associated power transmission facilities typically contain hazardous materials.

A number of recreational facilities are located on or adjacent to Shasta Lake. These facilities include marinas, campgrounds, day use facilities, and residences for recreational use. Although several of these are privately owned, most are operated under special use permits issued by USFS. Operation and maintenance of recreational facilities involve the use of a number of substances that are considered hazardous under Federal or State statutes. The STNF administrative facility at Turntable Bay contains substances used for maintenance of the facility, STNF boats, and recreation facilities throughout the NRA. Access to these substances is controlled by STNF in accordance with Federal, State, and local requirements. Additionally, public facilities that service and/or repair watercraft (e.g., marinas) generate wastes that are considered hazardous (e.g., oil, grease, solvents).

Currently, there are three underground fuel storage tanks permitted by the State Water Resources Control Board in the primary study area, all of which are in the Shasta Lake and vicinity portion of the primary study area: Holiday Harbor, Sugarloaf Marina, and Digger Bay Marina (State Water Board 2012). Also in the Shasta Lake and vicinity portion are four underground fuel storage tanks that are no longer in use due to regulatory actions resulting from documented occurrences of fuel leaks (State Water Board 2012).

The project would include the decommissioning/abandonment and/or relocation of a number of features and facilities on or adjacent to Shasta Lake. Underground and aboveground fuel storage tanks – including tanks in use and tanks no longer used – would be permanently removed from areas that would be inundated by the project. Above- and belowground fuel pipelines within the inundation area would be relocated/removed. Relocated fuel storage tanks would be designed and constructed in accordance with Title 23 of the California Code of Regulations (CCR) (Division 3, Chapter 15, Underground Tank Regulations); the Uniform Fire Code; California Air Resources Board; Shasta County Development Standards, Section 6.7; and Shasta County Environmental Health Division requirements. Additionally, the age of some buildings suggests that substances such as asbestos or lead paint may be included in demolition debris.

A records search of the Federal Superfund National Priorities List (NPL) (USEPA 2013) identified no sites in the Shasta Lake and vicinity portion of the study area. In its scoping comments, the Central Valley Regional Water Quality Control Board (CVRWQCB) identified three sites that are currently subject to some degree of remediation. These sites are associated with the Bully Hill/Rising Star Mine and the Digger Bay and Sugarloaf marinas. All three sites may be influenced by fluctuating water levels in Shasta Lake. An additional site near the Bully Hill Mine complex contains depositional features with elevated metal concentrations that are exposed to surficial and wave erosion processes. The CVRWQCB has also identified an abandoned mine complex west of Shasta Dam as a source of heavy metals and acid mine discharge that enters Shasta Lake via Dry Creek.

Interstate 5 (I-5) and Union Pacific Railroad transportation corridors are in close proximity to Shasta Lake and its tributaries. The potential exists for the accidental spill of chemicals and hazardous materials transported along these travel corridors. Transport through mountainous terrain and over water bodies, equipment failure, and improper storage and handling of hazardous materials contribute to the risk of accidental chemical spills.

The Cantara Spill is a prime example of the hazards associated with the transport of hazardous materials through the region. On July 14, 1991, a Southern Pacific train derailed upstream from Dunsmuir, sending several cars into the Sacramento River, including a tank car containing the herbicide/pesticide metam sodium (a potent chemical used principally to sterilize soil for agricultural purposes). A rupture in one of the tank cars resulted in the catastrophic spill of approximately 19,000 gallons of the soil fumigant into the river. When mixed with water, metam sodium breaks down into several highly toxic compounds. Although the toxins formed by the mixing of metam sodium with water dissipated in a matter of hours or weeks, the immediate effects of the spill were staggering. In the upper Sacramento River, every living aquatic creature downstream from the spill died over the 20-mile stretch of river between the spill and Shasta Lake (Cantara Trustee Council 2007). On July 17, 1991, the plume, estimated to have traveled at just under 1 mile per hour, entered Shasta Lake, where the chemical was reduced to undetectable levels approximately 2 weeks later. As a result of the Cantara Spill, more than $14 million in settlement funds – administered by the Cantara Trustee Council – was used for ecosystem restoration efforts throughout the primary study area.

Historic mining activities in the Shasta Lake and vicinity portion of the primary study area have left mine tailing deposits scattered throughout the uplands surrounding the lake. These deposits often contain high concentrations of various metals, including iron, copper, zinc, and mercury. The discharge of these dissolved metals into waterways can have an adverse effect on water quality, aquatic ecosystems, and human health. The historic Bully Hill Mine, located along the Squaw Arm, is the only mine site that would be inundated by the project. The effects on water quality that could result from the inundation of mine tailings are discussed in detail in Chapter 7, "Water Quality."

Upper Sacramento River (Shasta Dam to Red Bluff)

A number of business and industrial land uses downstream from Shasta Dam use and transport hazardous materials as part of their operations. Existing land uses that may have a hazardous material component include mining operations, heavy and light industrial uses, propane/petroleum fueling and/or storage facilities, and commercial and retail operations. Businesses that require storage of hazardous materials must submit a Hazardous Materials Business Plan (HMBP) to the Shasta County Environmental Health Department. I-5, Union Pacific Railroad lines, and several major surface routes are used for the transportation of hazardous materials throughout the region.

Hazardous waste sites associated with agricultural activities include storage facilities and agricultural ponds or pits contaminated with fertilizers, pesticides, herbicides, or insecticides. Petroleum products and other materials may also be present in the soil and groundwater near leaking underground tanks used to store these materials. However, there are no permitted underground fuel storage tanks – including tanks currently in use or tanks that have been subject to regulatory actions – within the project boundaries for the upper Sacramento River portion of the primary study area (State Water Board 2012).

Metals such as cadmium, copper, mercury, and zinc are present in inactive and abandoned mines in the upper Sacramento River area. Landfills and commercial activities, such as dry cleaning, could also be sources of contamination in this region. The project would not result in the inundation of any of these potentially hazardous locations.

A records search of the U.S. Environmental Protection Agency's (EPA) NPL identified one site in the upper Sacramento River area: Iron Mountain Mine. The mine is a privately owned site southwest of Shasta Dam and 9 miles northwest of Redding. The entire mine area, which encompasses about 2,000 acres, is drained by Boulder Creek and Slickrock Creek, tributaries to Spring Creek. Spring Creek enters Keswick Reservoir several miles downstream from Shasta Dam.

From the 1860s through 1963, the 4,400-acre Iron Mountain Mine was periodically mined for iron, silver, gold, copper, zinc, and pyrite. Although mining operations were discontinued in 1963, underground mine workings, waste rock dumps, piles of mine tailings, and an open mine pit remain at the site. Historic mining activity at Iron Mountain Mine has fractured the rock units, exposing minerals to surface water, rainwater, and oxygen. Acidic mine drainage typically contains high concentrations of copper, cadmium, zinc, and other heavy metals. Much of the acidic mine drainage ultimately is channeled into Spring Creek Reservoir via adjacent creeks and constructed diversion facilities. The low pH level and the heavy metal contamination from the mine have virtually extirpated aquatic life in sections of Slickrock Creek, Boulder Creek, and Spring Creek. (Project effects on potentially contaminated historic mine waste are discussed in Chapter 7, "Water Quality.")

Reclamation periodically releases water from Spring Creek Reservoir into Keswick Reservoir. Planned releases are timed to coincide with the presence of diluting releases of water from Shasta Dam. On occasion, uncontrolled spills and excessive waste releases have occurred when Spring Creek Reservoir reaches capacity. Without sufficient dilution, these events have resulted in the release of harmful quantities of heavy metals into the Sacramento River downstream from Keswick Dam. Acid mine drainage and associated heavy-metal contamination from the Spring Creek drainage and other abandoned mine sites are among the principal water quality issues in the upper Sacramento River portion of the primary study area (EPA 2008). In 2009, EPA began the removal of approximately 200,000 cubic yards of contaminated sediment from the Spring Creek Arm of Keswick Reservoir for disposal in an engineered disposal cell. The project was completed in 2010 and restored active storage space to Reclamation's Keswick Reservoir.

The Livingston Stone National Fish Hatchery facility, located at the foot of Shasta Dam, is used to propagate adult winter-run Chinook salmon collected from the mainstem Sacramento River. Water from Shasta Dam is used to supply the hatchery and waste is discharged to the Sacramento River downstream from the dam. The facility's discharge is regulated under CVRWQCB General Order R5-2010-0018 (National Pollutant Discharge Elimination System No. GAG135001) Waste Discharge Requirements for Cold-Water Concentrated Aquatic Animal Production Facility Discharges to Surface Waters (CVRWQCB 2010).

Lower Sacramento River and Delta and CVP/SWP Study Areas

Many of the land uses in the extended study area are similar to those in the primary study area. Thus, contamination is possible from agricultural, urban, industrial, commercial, landfill, and military land uses in the region. Because the extended study area covers many counties and regions, a records search of the NPL and the California Department of Toxic Substances Control list was not conducted. Although many sites in the extended study area undoubtedly are on these lists, it is not expected that these sites would be affected by project implementation.

Facilities created by CVP/SWP for the purposes of water conservation and management include dams, power plants, and an extensive canal system. Operation of these facilities involves the use of a variety of hazardous materials such as lubricants.

The Sacramento National Wildlife Refuge Complex consists of 5 national wildlife refuges and 3 wildlife management areas covering over 35,000 acres of wetlands and uplands, in addition to more than 30,000 acres of conservation easements. Many of the wetlands in the Sacramento Valley receive water not only from the Sacramento River, but also from agricultural runoff. Urban, industrial, agricultural, and natural sources of toxins contribute to water quality problems in the lower Sacramento River and Delta and can pose a hazard to fish and wildlife through processes such as bioaccumulation in the food chain.

A discussion of the current water quality and potential hazards to water quality associated with the project is presented in Chapter 7, "Water Quality."

9.2 Regulatory Framework

9.2.1 Federal

Federal Resource Conservation and Recovery Act

The Resource Conservation and Recovery Act (RCRA) is a Federal statute designed to provide “cradle to grave” control of hazardous waste by imposing management requirements on generators and transporters of hazardous wastes, and on owners and operators of treatment, storage, and disposal facilities. The EPA is responsible for administering the RCRA.

Federal Comprehensive Environmental Response, Compensation, and Liability Act

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), also known as the Superfund Act, provides for the liability, compensation, cleanup, and emergency response for hazardous substances released into the environment and the cleanup of inactive hazardous waste disposal sites. CERCLA authorized the NPL, which identifies contaminated sites that are eligible for remedial action. The scope of CERCLA is broad; it holds current and prior owners and operators of contaminated sites responsible, and its definition of a hazardous substance incorporates definitions from the Clean Air Act, the Clean Water Act, the Toxic Substances Control Act, and the RCRA (CERCLA Section 101(14)). EPA is the agency responsible for administering CERCLA.

Occupational Safety and Health Act

The Occupational Safety and Health Act defines occupational health and safety standards with the goal of providing employees with a safe working environment. The California Occupational Safety and Health Administration (Cal/OSHA) is the agency responsible for administering this Federal act. The Occupational Safety and Health Administration (OSHA) regulations apply to the workplace and cover activities ranging from confined space entry to toxic chemical exposure. Employers are required to provide a workplace free of recognized hazards that could cause serious physical harm. OSHA regulates workplace exposure to hazardous chemicals and activities through workplace procedures and equipment requirements (29 U.S. Code 651–678).

Hazardous Materials Transportation Act

The Hazardous Materials Transportation Act regulates interstate transport of hazardous materials and wastes. This act specifies driver training requirements, load labeling procedures, and container design and safety requirements. Transporters of hazardous wastes must also meet the requirements of other statutes, such as the RCRA. The Hazardous Materials Transportation Act requires that carriers report accidental releases of hazardous materials to the U.S. Department of Transportation at soon as is practical (49 CFR Subchapter C). Incidents that must be reported include deaths, injuries requiring hospitalization, and property damage exceeding $50,000. The U.S. Department of Transportation, the Federal Highway Administration, and the Federal Railroad Administration are the agencies responsible for administering the Hazardous Materials Transportation Act.

Code of Federal Regulations, Title 36

Title 36 of the CFR governs parks, forests, and public property in the United States. Chapter 2, Section 260, pertains to prohibited activities within the boundaries of Federally owned lands and waters administered by USFS. USFS is responsible for administering the regulations described as follows.

Section 261.5 Fire (General Prohibitions) The following are prohibited:

- Carelessly or negligently throwing or placing any ignited substance or other substance that may cause a fire
- Firing any tracer bullet or incendiary ammunition
- Causing timber, trees, slash, brush, or grass to burn except as authorized by permit
- Leaving a fire without completely extinguishing it
- Allowing a fire to escape from control
- Building, attending, maintaining, or using a campfire without removing all flammable material from around the campfire adequate to prevent its escape

Section 261.52 Fire (Prohibitions in Areas Designated by Order) When provided by an order, the following are prohibited:

- Building, maintaining, attending or using a fire, campfire, or stove fire
- Using an explosive
- Smoking, except within an enclosed vehicle or building, a developed recreation site, or while stopped in an area at least 3 feet in diameter that is barren or cleared of all flammable material
- Possessing, discharging, or using any kind of firework or other pyrotechnic device

Shasta-Trinity National Forest Land and Resource Management Plan

The STNF Land and Resource Management Plan (LRMP) contains goals, standards, and guidelines designed to guide the management of STNF. The following goals, standards, and guidelines relative to hazards and/or hazardous materials issues associated with the project area were excerpted from the LRMP (USFS 1995).

Facilities Goals (LRMP, p. 4-17)

- Provide and maintain those administrative facilities that effectively and safely serve the public and USFS work force.

Facilities Standards and Guidelines (LRMP, p. 4-17)

- Upgrade the surfacing on the forest's road system as necessary to protect the road and other resource values.
- Trails will be maintained as needed for specific management objectives. Erosion control and primary access will receive priority.
- Trails and trail bridges will be located, designed, constructed, and maintained so that they are suitable for the type of travel being served.
- Consider volcanic, seismic, flood, and slope stability hazards in the location and design of administrative and recreation facilities.
- Manage, construct, and maintain buildings and administrative sites to meet applicable codes and to provide the necessary facilities to support resource management.
- Monitor potable water sources and designated swimming areas according to the Safe Drinking Water Act and other regulatory health requirements.

Management Guide for the Shasta and Trinity Units of the Whiskeytown-Shasta-Trinity National Recreation Area

The NRA Management Guide (USFS 2014) contains management strategies intended to achieve or maintain a desired condition. These strategies take into account opportunities and general management and mitigation measures to achieve specific goals. STNF is responsible for administering the following strategies related to hazards and/or hazardous materials issues associated with the project area.

Fire and Fuels

- Hazardous fuels management issues are primarily focused in wildland-urban interface (WUI) areas. It is recommended that more than 75 percent of the fuels-reduction efforts take place in relation to these areas. Consideration is given to implementing one Community at Risk fuels reduction project each year. The non-WUI areas are focused on creating and maintaining a vegetative mosaic that reduces the potential for resource-damaging fire effects, improving forest health, and maintaining and improving habitat for associated animal and plant species.
- Fuels created by other management actions should be evaluated for further fuels treatment. For fuels management projects, all treatment

options should be evaluated during the planning process. Fuel treatment types should be considered in the context of the environment in which they will be located. Included in this decision should be location in reference to other past and future treatments, effects on wildlife, watersheds, and plant life, as well as the impacts on communities and infrastructure.

- Fuel breaks or Modified Fuel Profile Zones (MFPZ) are considered in areas where values at risk are very high and other options are limited due to proximity to those risks. These treatments are made in conjunction with other treatments to allow for a higher chance of success during a suppression event. Maintenance is a consideration in the planning of all MFPZs.

Health and Safety

- Resorts/marinas are responsible for inspecting their own facilities to ensure that they comply with applicable laws, ordinances, and codes and standards for health and safety and are safe for public use. Copies of all health and safety inspections must be incorporated in the operation and maintenance plan annually and be available to STNF.

- Marinas are required to anchor docks using underwater cables and anchor systems. Minor exceptions may be made, with STNF approval, in areas where low-speed boating is required, such as behind a marina in a semi-enclosed, restricted waterway. If cables and anchors are positioned in main travel-ways where they can come in contact with boats or people, the cables must be flagged and have warning lights so that they are visible day and night.

- Buoys and floats placed and maintained by marinas must meet the following criteria:

  – If the float or buoy is constructed of a material that will not damage a boat or cause personal injury on contact, the float or buoy must be of a contrasting color that can be easily seen. Examples are floats and buoys made of lightweight Styrofoam and plastic.

  – If the float or buoy is made of a material that could damage a boat or cause personal injury on contact, it must be of a contrasting color that can be easily seen, and must have a blinking yellow light visible from 360 degrees for night boating safety. Examples are floats and buoys made of steel or aluminum.

  – Log booms may be installed around marinas to suppress wave action at the docks. Log booms must not infringe on the main boating channels. Log booms must have yellow blinking lights installed every 100 feet on or immediately adjacent to the boom so that the boom's location is visible at night. Boating entrances through log booms or other breakwaters will display red and green navigation lights on either side of the log boom or breakwater for nighttime navigation.

  – All docks that are approved to extend out into a main boating travel-way, and are not protected by a lighted breakwater or other lighting system, must have at least one blinking yellow light for nighttime boating safety every 100 feet.

- No work that would leave pollutants in the lake when the area is inundated is permitted below the lake high-water line. Examples of this are water blasting and sand blasting pontoons and mechanical repairs that would allow oil and grease to drain on the ground.

- Resorts/marinas may restrict vehicle nighttime land access to their facilities if they can display to STNF that such action is needed to protect people and property.

Vegetation

- Prescribed burning, fuel break construction, and other forms of vegetation manipulation will be used to reduce fire hazards and improve forest health.

- Hazard trees in traditionally high-use recreation areas that pose safety hazards to people or property will be identified and removed if consistent with other resource objectives.

U.S. Bureau of Land Management Resource Management Plan

The U.S. Department of the Interior, Bureau of Land Management (BLM) manages a number of public lands adjacent to the Sacramento River corridor downstream from Shasta Dam. The study area falls under two BLM districts (Northern California and Central California) and the resource management plans of three BLM field offices: Redding, Ukiah, and Mother Lode (BLM 2006a). The purpose of BLM's resource management plans is to provide an overall direction for managing and allocating public resources in each planning area. BLM is responsible for administering the following strategies related to hazards and/or hazardous materials issues common to the districts in the study area (BLM 1992, 2006b, 2008).

Wildfire Suppression Goal

- Provide an appropriate management response for all wildland fires, emphasizing firefighter and public safety.

Fuels Management Goals

- Reduce fire risk to the WUI communities.

- Protect riparian and wetland areas.
- Improve ecological conditions and reduce the risk of catastrophic wildfire through the use of prescribed burning.
- Improve ecological conditions and reduce the risk of catastrophic wildfire through mechanical treatments.
- Increase the public's knowledge of the natural role of fire in the ecosystem, and hazards and risks associated with living in the WUI.

Hazardous Materials

- Land use authorizations will not be issued for uses that would involve the disposal or storage of materials that could contaminate the land (e.g., hazardous waste disposal sites, landfills, rifle ranges).
- Minimize hazardous conditions on BLM lands to reduce risks to the public and ensure environmental health and safety.

9.2.2 State

Strategic Fire Plan

The 2010 Strategic Fire Plan for California (State Board of Forestry and Fire Protection and Cal Fire 2010) is a broad strategic document that guides fire policy for much of California. It was authorized under California Public Resources Code Section 4114 and Section 4130 to establish, among other things, the levels of statewide fire protection services for State Responsibility Area lands. The plan is a cooperative effort between the State Board of Forestry and Fire Protection and Cal Fire. It emphasizes what needs to be done long before a fire starts, and looks at ways to reduce firefighting costs and property losses, increase firefighter safety, and contribute to ecosystem health. The plan serves as the basis for assessing California's complex and dynamic natural and human-made environment, and identifies a variety of actions to minimize the negative effects of wildland fire.

The mission of the State Board of Forestry and Fire Protection is to lead California in developing policies and programs that serve the public interest in environmentally, economically, socially sustainable forest and rangeland management, and a fire protection system that protects and serves the people of the state. Its statutory responsibilities are to:

- Establish and administer forest and rangeland policy for the State
- Protect and represent the State's interest in all forestry and rangeland matters

- Provide direction and guidance to Cal Fire on fire protection and resource management
- Accomplish a comprehensive regulatory program for forestry and fire protection
- Conduct its duties to inform and respond to the people of the State

Hazardous Waste Control Act

The California Hazardous Waste Control Act governs hazardous waste management and cleanup in the State (Health and Safety Code, Chapters 6.5–6.98). The act mirrors the RCRA and imposes a “cradle to grave” regulatory system for handling hazardous waste in a manner that protects human health and the environment. It requires all businesses to report the quantity and locations of hazardous materials on an annual basis if the business stores (a) more than 55 gallons of a liquid or 500 pounds of a solid hazardous material, (b) more than 200 cubic feet of a compressed gas, or (c) a radioactive material that is handled in quantities for which an emergency plan is required. Businesses falling within these limits must prepare an HMBP, which includes spill prevention, containment and emergency response measures and a contingency plan.

County Environmental Health Departments and the California Environmental Protection Agency’s (CalEPA) Certified Unified Program Agencies assume responsibility for enforcing local hazardous waste reporting requirements. Sites that store, handle, or transport specified quantities of hazardous materials are inspected annually. The California Department of Toxic Substances Control, part of CalEPA, regulates the generation, transportation, treatment, storage, and disposal of hazardous waste under the RCRA and the State Hazardous Waste Control Act.

Hazardous Substances Account Act

California enacted the Hazardous Substances Account Act (1981) to establish State authority to clean up hazardous substances releases, compensate persons injured from exposure to hazardous substances, and provide funds for payment of the State’s mandatory 10 percent share of cleanup costs under the Federal Superfund law. CalEPA administers the State Superfund program and receives assistance from the California Department of Public Health.

Emergency Response Plan

California developed an Emergency Response Plan to facilitate and coordinate responses to emergencies. Emergency prevention and response to hazardous materials incidents are part of the State plan that is administered by the California Emergency Management Agency (formerly Governor’s Office of Emergency Services). Coordinating agencies include CalEPA, the California Highway Patrol (CHP), Cal Fire, local fire departments, the California National

Guard, the California Department of Transportation (Caltrans), CDFW, regional water quality control boards, and other emergency service providers.

California Code of Regulations, Title 13, Vehicle Code

In addition to the RCRA hazardous waste transportation standards, California regulates the transportation of hazardous waste originating or passing through the state. State regulations are contained in the CCR, Title 13, Vehicle Code. Hazardous waste must be regularly removed from generating sites by licensed hazardous waste transporters. Transported materials must be accompanied by hazardous waste manifests.

CHP and Caltrans are responsible for enforcing Federal and State regulations pertaining to the transport of hazardous materials through California. CHP enforces materials and hazardous waste labeling and packaging regulations that prevent leakage and spills of material in transit and provides information to cleanup crews in the event of an incident. Vehicle and equipment inspection, shipment preparation, container identification, and shipping documentation are all part of the responsibility of CHP. CHP conducts regular inspections of licensed transporters to assure regulatory compliance. CHP and Caltrans also respond to hazardous materials transportation emergencies. Caltrans has emergency chemical spill identification teams at locations throughout the state.

Worker Safety Requirements

Regulations pertaining to the use of hazardous materials in California workplaces are provided in CCR Title 8 and include requirements for safety training, availability of safety equipment, accident and illness prevention programs, hazardous substance exposure warnings, and emergency action and fire prevention plan preparation. Cal/OSHA standards are more stringent than Federal OSHA regulations.

As described above, Cal/OSHA assumes primary responsibility for developing and enforcing workplace safety regulations in the state. Cal/OSHA enforces hazard communication program regulations that contain training and information requirements, including procedures for identifying and labeling hazardous substances, communicating information related to hazardous substances and their handling, and preparing health and safety plans to protect workers and employees at hazardous waste sites. The hazard communication program requires that material safety data sheets be available to employees and that employee information and training programs be documented.

Government Planning

California law requires that each county and city in the state adopt a general plan (Government Code Section 65300). The State-mandated general plans consist of development policies and objectives for the long-term physical development of counties and cities. Each general plan must include a safety element that addresses a variety of natural and human-caused hazards. At a minimum, the safety element must adopt policies related to fire safety, flooding, and geologic and seismic hazards (Government Code Section 65302(g)).

California Building Code

In 2007, the California Building Code was amended to include regulations pertaining to fire safety. The amendments provide safety standards for new construction located in WUI areas. The building code requires landowners to maintain an area of defensible space around structures and requires the use of fire-resistant building materials. County building inspectors, Cal Fire, and local fire agencies are responsible for enforcing the requirements (CCR Title 24, Part 2). On Federal lands, the Federal agency is responsible for ensuring that buildings and facilities meet public health and safety standards.

9.2.3 Regional and Local

County General Plans

The general plans for the counties in the primary and extended study areas contain general policies aimed at reducing the use of hazardous substances and the generation of hazardous waste and ensuring safe use and storage of hazardous materials and management of hazardous waste.

County Fire Management Plans

Fire Management Plans have been prepared for Tehama County and Shasta County (Cal Fire and Tehama Fire-Safe Council 2005; SCFD 2007; Cal Fire 2005). The plans tier from the California Fire Plan and are intended to be used for prefire planning, prioritization, and implementation. The plans outline cooperative efforts of local fire agencies, Cal Fire, and fire safe councils.

9.3 Environmental Consequences and Mitigation Measures

9.3.1 Methods and Assumptions

This analysis addresses potential impacts associated with implementation of the project with respect to hazards and hazardous materials. This analysis is based on a review of planning documents applicable to the project area, consultation with appropriate agencies, and field reconnaissance.

9.3.2 Criteria for Determining Significance of Effects

An environmental document prepared to comply with NEPA must consider the context and intensity of the environmental effects that would be caused by, or result from, the proposed action. Under NEPA, the significance of an effect is used solely to determine whether an EIS must be prepared. An environmental document prepared to comply with CEQA must identify the potentially significant environmental effects of a proposed project. A “[s]ignificant effect on the environment” means a substantial, or potentially substantial, adverse change in any of the physical conditions in the area affected by the project (State CEQA Guidelines, Section 15382). CEQA also requires that the environmental document propose feasible measures to avoid or substantially reduce significant environmental effects (State CEQA Guidelines, Section 15126.4(a)).

The following significance criteria are based on guidance provided by CEQA Guidelines (AEP 2010) and consider the context and intensity of the environmental effects as required under NEPA. Impacts of an alternative on hazards and hazardous materials would be significant if project implementation would do any of the following:

- Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials
- Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment
- Emit hazardous emissions or involve the handling of hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school
- Be located on a site that is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would create a significant hazard to the public or the environment
- Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan
- Expose people or structures to a significant risk of loss, injury, or death involving wildland fires

9.3.3 Topics Eliminated from Further Consideration

Water safety hazards posed by the project alternatives to water-based recreationists are assessed in Chapter 18; therefore, this topic has been eliminated from further analysis in this chapter. Similarly, the effects of hazardous materials on water quality are assessed in Chapter 7.

9.3.4 Direct and Indirect Effects

Information on fire risk and severity was obtained from USFS and Cal Fire. This information was used to identify specific types and locations of activities that could present a threat to the human environment as a result of wildland fires.

A regulatory database search was conducted for portions of the primary study area. The purpose of such a search was to identify sites that are associated with the documented use, generation, storage, or release of hazardous materials or petroleum products. The results also include regulatory lists of known or potential hazardous waste sites, landfills, hazardous waste generators, and disposal facilities, in addition to sites under investigation. Information provided in the database search was obtained from publicly available sources, including the following:

- Cortese List (DTSC 2012)
- Leaking Tanks (State Water Board 2012)
- Comprehensive Environmental Response, Compensation and Liability Information System: EPA Superfund Sites (USEPA 2013)
- Annual Work Plan (State Water Board et al. 2008)

No-Action Alternative

Shasta Lake and Vicinity, Upper Sacramento River (Shasta Dam to Red Bluff), Lower Sacramento and Delta, and CVP/SWP Service Areas

Impact Haz-1 (No-Action): Wildland Fire Risk Under the No-Action Alternative, no new facilities would be constructed in the primary or extended study areas and no changes in Reclamation's existing facilities or operations would occur that would directly or indirectly result in any increase in the risk of wildland fire in the project area. Therefore, no impact would occur. Mitigation is not required for the No-Action Alternative.

Impact Haz-2 (No-Action): Release of Potentially Hazardous Materials or Hazardous Waste Under the No-Action Alternative, no new facilities would be constructed in the primary or extended study areas and no changes in Reclamation's existing facilities or operations would occur that would directly or indirectly result in any increase in hazards, hazardous materials, or hazardous waste in the project area. Therefore, no impact would occur. Mitigation is not required for the No-Action Alternative.

Impact Haz-3 (No-Action): Exposure of Workers to Hazardous Materials Under the No-Action Alternative, no new facilities would be constructed in the primary or extended study areas and no changes in Reclamation's existing facilities or operations would occur that would directly or indirectly result in any increase in exposure of workers to hazards, hazardous materials, or hazardous waste in the project area. Therefore, no impact would occur. Mitigation is not required for the No-Action Alternative.

Impact Haz-4 (No-Action): Exposure of Sensitive Receptors to Hazardous Materials Under the No-Action Alternative, no new facilities would be constructed in the primary or extended study areas and no changes in Reclamation's existing facilities or operations would occur that would directly or indirectly result in any increase in hazards, hazardous materials, or hazardous waste in the project area. Therefore, no impact would occur. Mitigation is not required for the No-Action Alternative.

CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

Shasta Lake and Vicinity and Upper Sacramento River (Shasta Dam to Red Bluff)

Impact Haz-1 (CP1): Wildland Fire Risk Project implementation could contribute to wildland fire risk. Project construction and operation, and the anticipated postconstruction human activity in the primary study area would increase the potential for fire ignition. Therefore, this impact would be potentially significant.

Wildland fire in the primary study area would expose people, structures, infrastructure, and other resources to a significant risk of loss, injury, or death. Project design, implementation, and operation incorporate safety measures that prevent fire hazards. Although the construction details have not been finalized, this conclusion is based on the scope of activities involved and the fire hazard ratings (i.e., very high risk and extreme risk) in the primary study area and the relocation sites where project construction activities would occur. Construction activities would likely occur during the summer and fall months, which are generally considered a time of high fire hazard in Northern California. Reclamation and its contractors would follow fire safety regulations and procedures to prevent accidental fires.

Project activities associated with the removal and relocation of utilities could pose a wildland fire hazard in the primary study area, although it is anticipated that 100 percent vegetation clearance beneath high-voltage power transmission lines (typically 60-230 kilovolts) would be maintained. Under CP1, approximately 30,300 feet (5.7 miles) of power transmission lines and 59,400 feet (11.3 miles) of telecommunications lines would require demolition and relocation to prevent inundation by the new reservoir elevation resulting from project implementation. In addition, six power towers would be demolished, and six new towers would be constructed in new locations. CP1 also involves several miles of road construction and demolition of several vehicle and railroad bridges.

Other utility relocations and/or construction proposed under CP1 include potable water facilities, gas/petroleum facilities, and wastewater facilities. Vegetation clearing would be required to varying degrees for most utility relocation/construction, some of which would be located in densely vegetated areas. During construction/relocation, the potential would exist for the ignition of fire by construction equipment operating in the area. Although the increased risk of ignition would be short term (i.e., during implementation), it would be significant. CP1 would also include demolition and construction of recreational and public service facilities.

Relevant safety standards/procedures related to fire prevention would be incorporated into the project design, and would be used during construction activities and project operation and maintenance. Safety standards and procedures include the California Building Code; the Shasta County Fire Plan; USFS safety requirements regarding fire hazards; California Public Utilities Code General Order 95, which provides procedures for proper removal, disposal, and placement of poles, wires, and associated infrastructure; and the National Electric Safety Code (a voluntary code that provides safety procedures for electric utility installation and operation). Precautionary measures to prevent construction-related fires include locating utilities a safe distance from vegetation and structures, proper construction of power lines, and construction worker safety training. Postconstruction infrastructure operation and maintenance would follow current safety practices associated with fire prevention and would include clearing vegetation from power utility facilities and other sources using combustion engines (e.g., water pumps) on a regular basis.

Right-of-way easements obtained for transmission lines would be cleared of vegetation to provide for public and worker safety, and to provide reliable operations. The California Building Code, the National Electric Safety Code, and the Shasta County Fire Plan clearance requirements for power distribution facilities would be incorporated into the project design.

No new facilities or project construction would occur in the upper Sacramento River area. However, for purposes of the project, some aggregate material extraction may occur downstream from Shasta Dam. Construction activities downstream from Shasta Dam would increase the potential for fire starts due to the presence of highly flammable vegetation. In addition, vegetation below Shasta Dam would be susceptible to fires started elsewhere within the primary study area or surrounding areas.

Project materials and workers traveling to the construction sites from the upper Sacramento River area could also increase the risk of fire hazard over their route. Operation of motor vehicles throughout the region, particularly when vegetation adjacent to roadways is dry, imparts a certain level of fire potential from accidental combustion (e.g., sparks), hot metal (e.g., tail pipes, motors), or traffic accidents which could result in fire.

Project activities, including those intended to mitigate impacts on vegetation, are expected to reduce the overall fuel loading around the Shasta Lake and vicinity portion of the primary study area, thereby reducing the long-term fire hazard. In addition, the project could result in additional water supplies in the primary study area, which could assist future fire responses in the primary study area.

Project activities would increase the risk of wildland fires. Therefore, this impact would be potentially significant. Mitigation for this impact is proposed in Section 9.3.5.

Impact Haz-2 (CP1): Release of Potentially Hazardous Materials or Hazardous Waste Project construction and operation would involve the transportation, use, or storage of hazardous materials. Local, State, and Federal safety codes and procedures related to hazardous material transport, handling, and disposal would be followed for project construction and operation to minimize the risk of a hazardous materials release. However, an accidental release resulting from project activities could expose the public and the environment to a significant safety hazard. Therefore, this impact would be potentially significant.

Project facilities proposed for construction under CP1 would be located in the Shasta Lake and vicinity portion of the primary study area. Certain hazardous materials needed for construction and operation would need to be stored at the Shasta Dam facility and at other utility and infrastructure relocation sites around the primary study area. Certain hazardous materials would be used to operate equipment both during and after construction, and the construction, and operation, and maintenance of project facilities and infrastructure would require the use of potentially hazardous materials such as paint, concrete, and wood preservatives. In addition, industrial uses associated with the operation and maintenance of the modified Shasta Dam compound would require the use, storage, and routine transport of small quantities of hydraulic fluids, solvents, and other standard mechanical maintenance fluids.

Construction staging, and equipment and materials storage, including storage of possible contaminants, and equipment maintenance in the primary study area would occur in areas specified by Reclamation. Staging areas would likely be located in disturbed areas or existing facilities that would be inundated after the dam is raised, such as campgrounds, recreation parking facilities, the top of Shasta Dam, and the parking area along the left wing dam. All staging areas would be located at least 100 feet from bodies of water, wherever possible. Equipment refueling and maintenance would not occur within 100 feet of water bodies, wherever possible.

Seven existing gas/petroleum facilities would be subject to inundation under CP1 and would be relocated subsequent to demolition. The existing fuel tanks would be excavated and all associated piping would be removed. Hazardous material tests and removal would be performed, as required, in accordance with Title 23 CFR, Division 3, Chapter 16: Underground Tank Regulations, and in accordance with Shasta County Environmental Health Division requirements. In addition to adherence to the directives of Title 23, relocated tanks would be designed and constructed in accordance with the Uniform Fire Code; California Air Resources Board; Shasta County Development Standards, Section 6.7 (December 1997); and Shasta County Environmental Health Division requirements. Relocated tanks would be located in cleared areas with code-mandated clearances from other facilities.

Aggregate material for the project could originate from the drawdown portion of Shasta Lake and from areas downstream from Shasta Dam (e.g., Churn Creek bottom, Clear Creek confluence, Keswick Reservoir). These materials could contain hazardous substances such as mercury or selenium. Hazardous materials released into area waterways, including Shasta Lake and many upper Sacramento River tributaries, come from past land use activities (e.g., mining) or natural sources (e.g., asbestos, selenium) and are likely to be trapped in lake-bottom, river, or floodplain sediments.

Aggregate extraction could also require operation of heavy equipment next to and in Shasta Lake or the upper Sacramento River. Reclamation may use aggregate supplies from Shasta Lake or the upper Sacramento River floodplain for dam construction materials in the general vicinity of Bridge Bay Marina and Lakeshore Drive. Several additional aggregate sources near the existing shoreline of Shasta Lake are also being considered (e.g., Bass Mountain, Stillwater Creek valley, Gray Rocks). Excavation and extraction of aggregate from these sources, or the augmentation of gravel in the Sacramento River, would require the use of construction equipment, which would involve the use of various hazardous materials such as fuel, oils, grease, and other petroleum products. These contaminants could be introduced into water systems, either directly or through surface runoff.

Project implementation could result in dam operations that would inundate abandoned or inoperative mines located next to Shasta Lake. Areas adjacent to the Bully Hill/Rising Star property contain hazardous materials that would affect Shasta Lake. The effects of CP1 on mines in the primary study area and the upper Sacramento River are discussed in Chapter 7.

Four vehicle bridges would be removed under CP1: Charlie Creek Bridge, Doney Creek Bridge, McCloud River Bridge, and Didallas Creek Bridge. A fifth bridge, the Fender's Ferry Bridge, would be retained and modified to accommodate Shasta Dam raises. Bridge demolition or modification, as well as the demolition of other structures and facilities that would be inundated under CP1, could require handling of hazardous waste including asbestos, lead paint, and wood preservatives. This hazardous waste, along with any additional forms of hazardous waste materials generated by project construction, would be removed to an approved landfill for disposal per permit requirements. Transport of hazardous materials would be conducted in accordance with CCR Title 26 and would be licensed by the CHP, pursuant to California Vehicle Code Section 32000, which requires proper packaging and licensing by hazardous materials haulers.

The environmental commitments for all action alternatives include the development and implementation of a construction management plan, erosion and sediment control plan, stormwater pollution prevention plan, and revegetation plan, as well as water quality and fisheries conservation measures and compliance with all required permit terms and conditions. However, the accidental release of hazardous materials or waste could expose the public and the environment to a significant safety hazard. Therefore, this impact would be potentially significant. Mitigation for this impact is proposed in Section 9.3.5.

Impact Haz-3 (CP1): Exposure of Workers to Hazardous Materials Project implementation could result in the exposure of workers to hazardous materials. The project would require the use of potentially hazardous materials to operate construction equipment and to construct various facilities. Reclamation and project contractors would follow local, State, and Federal regulations and procedures for properly transporting, handling, and storing hazardous materials and hazardous waste to decrease the risk of exposure; however, there is a possibility of accidents that could expose project workers to hazardous materials. Structures proposed for demolition, such as bridges, may contain asbestos, lead paint, toxic wood preservatives, or other hazardous substances. Fuel tanks and utility infrastructure (e.g., transformers containing PCBs) proposed for relocation also would involve some risk of exposure to hazardous substances. However, at this time it appears that the quantities and types of hazardous materials and possible exposure levels to these materials in the workplace would not pose a significant risk to worker health and safety. Furthermore, there are no known hazardous waste sites in the primary study area. Therefore, this impact would be less than significant.

Project workers would be required to transport hazardous materials at various times, in various quantities, and for various stages of project development. I-5 and local roadways would be used to transport hazardous materials and hazardous waste to and from Shasta Lake and vicinity during construction and dam operations. Traffic accidents or equipment failure could expose project workers to hazardous materials. Reclamation and contractors would follow appropriate safety procedures to minimize these risks.

Project construction activities associated with utility line removal and relocation could expose workers to health risks associated with wood preservatives used on wooden utility poles and PCBs, which are commonly found in transformers. Approximately 53,600 feet (10.2 miles) of power and telecommunication lines and six power towers would be demolished and relocated to avoid inundation resulting from the proposed change in Shasta Lake’s elevation. A large number of wooden utility poles would be demolished and relocated outside of the inundation area. Construction activities associated with utility demolition and relocation are estimated to take up to 5 years. During that time, workers handling utility poles and transformers would follow protocols to minimize exposure to hazardous material and hazardous waste.

Aggregate extraction from sites in the primary study area that may contain hazardous materials entrained in sediments, such as mercury, could result in the exposure of workers to toxic substances. During construction, workers involved in gravel extraction activities would follow protocols to minimize exposure to hazardous materials.

Shasta Dam operations could expose workers at the facility to hazardous materials. Dam operations require the use of fuels, oils, greases, and solvents. Additional amounts of hazardous materials, beyond the volumes required for operation of the existing structure, may be needed to operate the expanded raised dam structure. Reclamation would update its HMBP and would ensure that its employees follow CalEPA and OSHA standards for handling hazardous waste.

In summary, the quantities and types of hazardous materials and possible exposure levels to these materials in the workplace would not pose a significant risk to worker health and safety. Furthermore, there are no known hazardous waste sites in the primary study area. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Haz-4 (CP1): Exposure of Sensitive Receptors to Hazardous Materials
Project implementation could expose sensitive receptors to hazardous materials and waste that would be transported through the primary study area. A school and park, as well as numerous homes, are located in Shasta Lake City about 4 miles from Shasta Dam. Project activity would occur while school is in session, and the park is open to the public year round. Although Reclamation would implement measures to lessen the risk of hazardous materials exposure to sensitive receptors, this impact would be potentially significant.

Project implementation could expose sensitive receptors to hazardous materials and waste that would be transported through the primary study area. Travel routes to and from the primary study area are limited (i.e., there are few roads); thus, construction traffic would have to use I-5 and local roads, such as Shasta Dam Boulevard and/or Lake Boulevard. A school and park, as well as numerous homes, are located in Shasta Lake City at the intersection of Shasta Dam Boulevard and Lake Boulevard, about 4 miles from Shasta Dam. Project activity would occur while school is in session. The park is open to the public year round. This park is the primary venue for a number of youth and adult sport programs.

Aside from scattered residential and recreation areas throughout the primary study area, it does not appear that any other sensitive receptors (e.g., hospitals, schools) in the primary study area would be placed at risk of exposure to hazardous materials as a result of the project. Project implementation would follow local, State, and Federal regulations and procedures regarding the transport of hazardous materials.

Although Reclamation would implement measures to lessen the risk of hazardous materials exposure to sensitive receptors, this impact would be potentially significant. Mitigation for this impact is proposed in Section 9.3.5.

Lower Sacramento River and Delta and CVP/SWP Service Areas
Impact Haz-5 (CP1): Wildland Fire Risk No new facilities or project construction in the extended study area would affect the potential for wildland fire. Construction materials would be transported and workers would travel to the extended study area via I-5. However, the typical quick response to traffic accidents and fires ignited along roadways significantly decreases the potential for a wildland fire being accidentally ignited by project-related traffic. Therefore, this impact would be less than significant.

No new facilities or project construction would occur in the extended study area that would affect the existing potential for wildland fire. Construction materials would be transported and workers would travel to the extended study area from outlying areas via I-5. The potential would exist for truck and vehicular traffic associated with the project to ignite a fire as the result of an accident, a spark, or overheating. However, traffic accidents and fires ignited along roadways typically receive quick local emergency assistance, which includes fire protection. This typical response significantly decreases the potential for a wildland fire being accidentally ignited by project-related traffic. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and is thus not proposed.

Impact Haz-6 (CP1): Release of Potentially Hazardous Materials or Hazardous Waste No new facilities or project construction in the extended study area would result in the release of hazardous material or waste. Transport of hazardous materials would be conducted in accordance with CCR Title 26 and would be licensed by the CHP, pursuant to California Vehicle Code Section 32000, which requires proper packaging and licensing by hazardous materials haulers and approved by Caltrans. Therefore, this impact would be less than significant.

No new facilities or project construction would occur in the extended study area that would directly or indirectly result in the release of hazardous material or waste. Although hazardous materials used for or generated by the project in the primary study area may be transported through the extended study area, the potential for their release into the environment is less than significant. Hazardous waste generated by the project in the primary study area would likely be disposed of in landfills in the extended study area, and would likely include utility poles, transformers, asbestos, or lead-based paint. Construction equipment would also generate petroleum product waste. Petroleum products would likely be reclaimed in the primary study area. Other hazardous waste would go to one of three EPA-certified commercial hazardous waste landfills in the state. They are all located in Kings, Kern, and Imperial counties.

Transport of hazardous materials would be conducted in accordance with CCR Title 26 and would be licensed by the CHP, pursuant to California Vehicle Code Section 32000, which requires proper packaging and licensing by hazardous materials haulers and approved by Caltrans. Highly explosive hazardous waste and large amounts of liquid hazardous waste or are not anticipated to be transported out of the primary study area for disposal. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Haz-7 (CP1): Exposure of Workers to Hazardous Materials Project implementation would not result in new facilities or construction in the extended study area. Hazardous material transport and safety procedures for hazardous material transported through the extended study area would be sufficient to minimize risks to workers. Therefore, this impact would be less than significant.

Project implementation would not result in new facilities or construction in the extended study area. Workers may be required to transport hazardous materials through the extended study area for project purposes and could be exposed to the materials in the case of an accidental spill. However, hazardous material transport and safety procedures for hazardous material transported through the extended study area would be sufficient to minimize risks to workers. Workers involved in hazardous waste disposal activities would follow CalEPA and OSHA hazardous material and waste handling rules and regulations. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Haz-8 (CP1): Exposure of Sensitive Receptors to Hazardous Materials or Hazardous Waste No new facilities or project construction would occur in the extended study area that would directly or indirectly result in the exposure of sensitive receptors to hazardous materials or hazardous waste. Therefore, this impact would be less than significant.

Hazardous materials needed for construction or operation of the project and hazardous waste generated in the primary study area would be transported through the extended study area. Accidental spills of hazardous materials or waste during transport are possible; however, hazardous waste haulers and hazardous materials suppliers would adhere to all safety precautions and regulations pertaining to hazardous material and hazardous waste transport. These actions would minimize the risk of exposure to hazardous materials or hazardous waste by sensitive receptors in the extended study area. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

Shasta Lake and Vicinity and Upper Sacramento River (Shasta Dam to Red Bluff)

Impact Haz-1 (CP2): Wildland Fire Risk Project implementation could contribute to wildland fire risk. Project construction and operation, and the anticipated postconstruction human activity in the primary study area would increase the potential for fire ignition. Therefore, this impact would be potentially significant.

This impact would be similar to Impact Haz-1 (CP1). Activities that could result in wildland fire risks would be the same as those discussed for Impact Haz-1 (CP1). However, the larger inundation area proposed under CP2 would require that more utilities, public service, and recreational facilities be demolished and relocated than under CP1, and would require that more vegetation be cleared within the inundation area. The additional construction and mechanized vegetation clearing associated with CP2 would require prolonged operation of construction equipment in vegetated areas and increase the potential for fire ignition from motor vehicle operation and the presence of charged utility lines in areas with a high fire hazard potential. A proposed increase in the number of campground/day use recreation areas (261 versus 202 for CP1) would increase the potential for wildfire ignition. Therefore, this impact would be potentially significant. Mitigation for this impact is proposed in Section 9.3.5.

Impact Haz-2 (CP2): Release of Potentially Hazardous Materials or Hazardous Waste Project construction and operation would involve the transportation, use, or storage of hazardous materials. Local, State, and Federal safety codes and procedures related to hazardous material transport, handling, and disposal would be followed for project construction and operation to minimize the risk of a hazardous materials release. However, an accidental release resulting from project activities could expose the public and the environment to a significant safety hazard. Therefore, this impact would be potentially significant.

This impact would be similar to Impact Haz-2 (CP1). However, the amount of potentially hazardous materials required for construction and operation of the project, and the volume of hazardous waste generated by project construction, could be greater for CP2 than for CP1. The number of bridge relocations, aggregate extraction or augmentation actions, and operations and maintenance of CP2 would be similar to but greater than those of CP1. Infrastructure relocation actions would require that land- and water-based construction and maintenance equipment operate in and adjacent to Shasta Lake and other potentially sensitive areas. Hazardous materials from leaking equipment, improper handling, or accidental spills could enter the lake, waterways, or adjacent land. Also under CP2, 10 gas/petroleum tanks would be excavated and relocated to avoid inundation. Therefore, this impact would be potentially significant. Mitigation for this impact is proposed in Section 9.3.5.

Impact Haz-3 (CP2): Exposure of Workers to Hazardous Materials Project implementation could result in the exposure of workers to hazardous materials. The project would require the use of potentially hazardous materials to operate construction equipment and to construct various facilities. Reclamation and project contractors would follow local, State, and Federal regulations and procedures for properly transporting, handling, and storing hazardous materials and hazardous waste to decrease the risk of exposure; however, there is a possibility of accidents that could expose project workers to hazardous materials. Structures proposed for demolition, such as bridges, may contain asbestos, lead paint, toxic wood preservatives, or other hazardous substances. Fuel tanks and utility infrastructure (e.g., transformers containing PCBs) proposed for relocation also would involve some risk of exposure to hazardous substances. However, at this time it appears that the quantities and types of hazardous materials and possible exposure levels to these materials in the workplace would not pose a significant risk to worker health and safety. Furthermore, there are no known hazardous waste sites in the primary study area. Therefore, this impact would be less than significant.

This impact would be similar to Impact Haz-3 (CP1). CP2 would require the use of potentially hazardous materials during construction, operation, and maintenance of the project. The larger scale of CP2 compared to CP1 would also generate a larger volume of hazardous waste resulting from utility line and infrastructure demolition. However, workers involved in hazardous waste disposal activities would follow CalEPA and OSHA hazardous material and waste handling rules and regulations. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Haz-4 (CP2): Exposure of Sensitive Receptors to Hazardous Materials Project implementation could expose sensitive receptors to hazardous materials and waste that would be transported through the primary study area. A school and park, as well as numerous homes, are located in Shasta Lake City about 4 miles from Shasta Dam. Project activity would occur while school is in session, and the park is open to the public year round. Although Reclamation would implement measures to lessen the risk of hazardous materials exposure to sensitive receptors, this impact would be potentially significant.

This impact would be similar to Impact Haz-4 (CP1). Project implementation could expose sensitive receptors to hazardous materials and waste that would be transported through the primary study area. Travel routes to and from the primary study area are limited (i.e., there are few roads); thus, construction traffic would have to use I-5 and local roads, such as Shasta Dam Boulevard and/or Lake Boulevard. A school and park, as well as numerous homes are located in Shasta Lake City at the intersection of Shasta Dam Boulevard and Lake Boulevard, about 4 miles from Shasta Dam. Although the scale of project actions proposed under CP2 would be larger than that of CP1, the primary study area would remain the same. Therefore, this impact would be potentially significant. Mitigation for this impact is proposed in Section 9.3.5.

Lower Sacramento River and Delta and CVP/SWP Service Areas

Impact Haz-5 (CP2): Wildland Fire Risk No new facilities or project construction in the extended study area would affect the potential for wildland fire. Construction materials would be transported and workers would travel to the extended study area via I-5. However, the typical quick response to traffic accidents and fires ignited along roadways significantly decreases the potential for a wildland fire being accidentally ignited by project-related traffic. Therefore, this impact would be less than significant.

This impact would be similar to Impact Haz-5 (CP1). No new facilities or project construction would occur in the extended study area that would affect the existing potential for wildland fire. The potential for an increased risk of fire resulting from haul trucks associated with the project would be negligible. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Haz-6 (CP2): Release of Potentially Hazardous Materials or Hazardous Waste No new facilities or project construction in the extended study area would result in the release of hazardous material or waste. Transport of hazardous materials would be conducted in accordance with CCR Title 26 and would be licensed by the CHP, pursuant to California Vehicle Code Section 32000, which requires proper packaging and licensing by hazardous materials haulers and approved by Caltrans. Therefore, this impact would be less than significant.

This impact would be similar to Impact Haz-6 (CP1). No new facilities or project construction would occur in the extended study area that would result in the direct or indirect release of hazardous material or waste. The potential for an increased risk of hazardous materials spills resulting from haul trucks associated with the project would be negligible. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Haz-7 (CP2): Exposure of Workers to Hazardous Materials Project implementation would not result in new facilities or construction in the extended study area. Hazardous material transport and safety procedures for hazardous material transported through the extended study area would be sufficient to minimize risks to workers. Therefore, this impact would be less than significant.

This impact would be similar to Impact Haz-7 (CP1). Project implementation would not result in new facilities or construction in the extended study area. Workers involved in hazardous waste disposal activities would follow CalEPA and OSHA hazardous material and waste handling rules and regulations. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Haz-8 (CP2): Exposure of Sensitive Receptors to Hazardous Materials or Hazardous Waste No new facilities or project construction would occur in the extended study area that would directly or indirectly result in the exposure of sensitive receptors to hazardous materials or hazardous waste. Therefore, this impact would be less than significant.

This impact would be similar to Impact Haz-8 (CP1). No new facilities or project construction would occur in the extended study area that would result in the direct or indirect exposure of sensitive receptors to hazardous materials or hazardous waste. The potential for the exposure of sensitive receptors to hazard materials or waste associated with the project would be negligible. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CP3 – 18.5-Foot Dam Raise, Agricultural Water Supply Reliability and Anadromous Fish Survival

Shasta Lake and Vicinity and Upper Sacramento River (Shasta Dam to Red Bluff)

Impact Haz-1 (CP3): Wildland Fire Risk Project implementation could contribute to wildland fire risk. Project construction and operation, and the anticipated postconstruction human activity in the primary study area would increase the potential for fire ignition. Therefore, this impact would be potentially significant.

This impact would be similar to Impact Haz-1 (CP1). However, the larger inundation area proposed under CP3 would require that more utilities, public service, and recreational facilities be demolished and relocated than under CP1, and would require that more vegetation be cleared within the inundation area. The larger scale of utility line and road construction, and the vegetation clearing and grubbing associated with CP3 would require prolonged operation of construction equipment in vegetated areas and increase the potential for fire ignition that comes from motor vehicle operation and the presence of charged utility lines in areas with a high fire hazard potential. A proposed increase in the number of campground/day use recreation areas (328 versus 202 (CP1) or 261 (CP2)) would also increase the potential for wildfire ignition. This impact would be potentially significant. Mitigation for this impact is proposed in Section 9.3.5.

Impact Haz-2 (CP3): Release of Potentially Hazardous Materials or Hazardous Waste Project construction and operation would involve the transportation, use, or storage of hazardous materials. Local, State, and Federal safety codes and procedures related to hazardous material transport, handling, and disposal would be followed for project construction and operation to minimize the risk of a hazardous materials release. However, an accidental release resulting from project activities could expose the public and the environment to a significant safety hazard. Therefore, this impact would be potentially significant.

This impact would be similar to Impact Haz-2 (CP1). However, the amount of potentially hazardous materials required for construction and operation of the project and the volume of hazardous waste generated by project construction could be greater for CP3 than either CP1 or CP2. The number of bridge relocations, aggregate extraction or augmentation actions, and operations and maintenance of CP3 would be similar to but greater than those of CP1 and CP2. However, infrastructure relocation actions would require that land- and water-based construction and maintenance equipment operate in and adjacent to Shasta Lake and other potentially sensitive areas. Hazardous materials from leaking equipment, improper handling, or accidental spills could enter the lake, waterways, or adjacent land. Under CP3, 10 gas/petroleum tanks would be excavated and relocated to avoid inundation. This impact would be potentially significant. Mitigation for this impact is proposed in Section 9.3.5.

Impact Haz-3 (CP3): Exposure of Workers to Hazardous Materials Project implementation could result in the exposure of workers to hazardous materials. The project would require the use of potentially hazardous materials to operate construction equipment and to construct various facilities. Reclamation and project contractors would follow local, State, and Federal regulations and procedures for properly transporting, handling, and storing hazardous materials and hazardous waste to decrease the risk of exposure; however, there is a possibility of accidents that could expose project workers to hazardous materials. Structures proposed for demolition, such as bridges, may contain asbestos, lead paint, toxic wood preservatives, or other hazardous substances. Fuel tanks and utility infrastructure (e.g., transformers containing PCBs) proposed for relocation also would involve some risk of exposure to hazardous substances. However, at this time it appears that the quantities and types of hazardous materials and possible exposure levels to these materials in the workplace would not pose a significant risk to worker health and safety. Furthermore, there are no known hazardous waste sites in the primary study area. Therefore, this impact would be less than significant.

This impact would be similar to Impact Haz-3 (CP1). CP3 would require the use of potentially hazardous materials during construction, operation, and maintenance of the project. The larger scale of CP3 compared to CP1 or CP2 would also generate a larger volume of hazardous waste resulting from utility line demolition. However, workers involved in hazardous waste disposal activities would follow CalEPA and OSHA hazardous material and waste handling rules and regulations. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Haz-4 (CP3): Exposure of Sensitive Receptors to Hazardous Materials Project implementation could expose sensitive receptors to hazardous materials and waste that would be transported through the primary study area. A school and park, as well as numerous homes, are located in Shasta Lake City about 4 miles from Shasta Dam. Project activity would occur while school is in session, and the park is open to the public year round. Although Reclamation would implement measures to lessen the risk of hazardous materials exposure to sensitive receptors, this impact would be potentially significant.

This impact would be similar to Impact Haz-4 (CP1). Project implementation could expose sensitive receptors to hazardous materials and waste that would be transported through the primary study area. Travel routes to and from the primary study area are limited (i.e., there are few roads); thus, construction traffic would have to use I-5 and local roads, such as Shasta Dam Boulevard and/or Lake Street. A school and park, as well as numerous homes, are located in Shasta Lake City at the intersection of Shasta Dam Boulevard and Lake Boulevard, about 4 miles from Shasta Dam. Although the scale of project actions proposed under CP3 would be larger than that of CP1 or CP2, the primary study area would remain the same. Therefore, this impact would be potentially significant. Mitigation for this impact is proposed in Section 9.3.5.

Lower Sacramento River and Delta and CVP/SWP Service Areas
Impact Haz-5 (CP3): Wildland Fire Risk No new facilities or project construction in the extended study area would affect the potential for wildland fire. Construction materials would be transported and workers would travel to the extended study area via I-5. However, the typical quick response to traffic accidents and fires ignited along roadways significantly decreases the potential for a wildland fire being accidentally ignited by project-related traffic. Therefore, this impact would be less than significant.

This impact would be similar to Impact Haz-5 (CP1). No new facilities or project construction would occur in the extended study area that would affect the existing potential for wildland fire. The potential for an increased risk of fire resulting from haul trucks and construction traffic associated with the project would be negligible. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Haz-6 (CP3): Release of Potentially Hazardous Materials or Hazardous Waste No new facilities or project construction in the extended study area would result in the release of hazardous material or waste. Transport of hazardous materials would be conducted in accordance with CCR Title 26 and would be licensed by the CHP, pursuant to California Vehicle Code Section 32000, which requires proper packaging and licensing by hazardous materials haulers and approved by Caltrans. Therefore, this impact would be less than significant.

This impact would be similar to Impact Haz-6 (CP1). No new facilities or project construction would occur in the extended study area that would result in the direct or indirect release of hazardous material or waste. The potential for an increased risk of hazardous materials spills resulting from haul trucks associated with the project would be negligible. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Haz-7 (CP3): Exposure of Workers to Hazardous Materials Project implementation would not result in new facilities or construction in the extended study area. Hazardous material transport and safety procedures for hazardous material transported through the extended study area would be sufficient to minimize risks to workers. Therefore, this impact would be less than significant.

This impact would be similar to Impact Haz-7 (CP1). Project implementation would not result in new facilities or construction in the extended study area. Workers involved in hazardous waste disposal activities would follow CalEPA and OSHA hazardous material and waste handling rules and regulations. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Haz-8 (CP3): Exposure of Sensitive Receptors to Hazardous Materials or Hazardous Waste No new facilities or project construction would occur in the extended study area that would directly or indirectly result in the exposure of sensitive receptors to hazardous materials or hazardous waste. Therefore, this impact would be less than significant.

This impact would be similar to Impact Haz-8 (CP1). No new facilities or project construction would occur in the extended study area that would result in the direct or indirect exposure of sensitive receptors to hazardous materials or hazardous waste. The potential for the exposure of sensitive receptors to hazardous materials or waste associated with the project would be negligible. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CP4 and CP4A – 18.5-Foot Dam Raise, Anadromous Fish Focus with Water Supply Reliability

Shasta Lake and Vicinity and Upper Sacramento River (Shasta Dam to Red Bluff)

Impact Haz-1 (CP4 and CP4A): Wildland Fire Risk Project implementation could contribute to wildland fire risk. Project construction and operation, and the anticipated postconstruction human activity in the primary study area would increase the potential for fire ignition. Therefore, this impact would be potentially significant for CP4 or CP4A.

This impact would be similar to Impact Haz-1 (CP3), except that vehicles and equipment involved in the gravel augmentation and habitat restoration actions in the upper Sacramento River habitat restoration project would slightly increase the potential for wildland fires.

This impact would be potentially significant for CP4. Mitigation for this impact is proposed in Section 9.3.5.

This impact would be potentially significant for CP4A. Mitigation for this impact is proposed in Section 9.3.5.

Impact Haz-2 (CP4 and CP4A): Release of Potentially Hazardous Materials or Hazardous Waste Project construction and operation would involve the transportation, use, or storage of hazardous materials. Local, State, and Federal safety codes and procedures related to hazardous material transport, handling, and disposal would be followed for project construction and operation to minimize the risk of a hazardous materials release. However, an accidental release resulting from project activities could expose the public and the environment to a significant safety hazard. Therefore, this impact would be potentially significant for CP4 or CP4A.

This impact would be similar to Impact Haz-2 (CP3), except that vehicles and equipment involved in the gravel augmentation and habitat restoration actions in the upper Sacramento River would slightly increase the potential for release of hazardous materials or waste.

Under CP4 or CP4A, the major components described for CP3 would be implemented, with additional measures for increasing habitat for anadromous fish. These measures include the placement of spawning-sized gravel at multiple locations along the Sacramento River between Keswick Dam and the RBPP. Under CP4 and CP4A, riparian, floodplain, and side channel habitat restoration would be implemented at up to six potential sites on the upper Sacramento River to restore habitat for anadromous salmonids.

Aggregate extraction and/or augmentation activities under CP4 or CP4A could release hazardous substances (e.g., mercury) entrained in these gravels into the water. The gravel augmentation or the construction of habitat restoration actions could cause hazardous materials to enter nearby waterways or adjacent land from leaking equipment, improper handling, or accidental spills.

This impact would be potentially significant for CP4. Mitigation for this impact is proposed in Section 9.3.5.

This impact would be potentially significant for CP4A. Mitigation for this impact is proposed in Section 9.3.5.

Impact Haz-3 (CP4 and CP4A): Exposure of Workers to Hazardous Materials Project implementation could result in the exposure of workers to hazardous materials. The project would require the use of potentially hazardous materials to operate construction equipment and to construct various facilities. Reclamation and project contractors would follow local, State, and Federal regulations and procedures for properly transporting, handling, and storing hazardous materials and hazardous waste to decrease the risk of exposure; however, there is a possibility of accidents that could expose project workers to hazardous materials. Structures proposed for demolition, such as bridges, may contain asbestos, lead paint, toxic wood preservatives, or other hazardous substances. Fuel tanks and utility infrastructure (e.g., transformers containing PCBs) proposed for relocation also would involve some risk of exposure to hazardous substances. However, at this time it appears that the quantities and types of hazardous materials and possible exposure levels to these materials in the workplace would not pose a significant risk to worker health and safety. Furthermore, there are no known hazardous waste sites in the primary study area. Therefore, this impact would be less than significant for CP4 or CP4A.

This impact would be similar to Impact Haz-3 (CP3), with additional measures for increasing habitat for anadromous fish, which would slightly increase the potential for the exposure of workers to hazardous materials or hazardous waste.

This impact would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

This impact would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact Haz-4 (CP4 and CP4A): Exposure of Sensitive Receptors to Hazardous Materials Project implementation could expose sensitive receptors to hazardous materials and waste that would be transported through the primary study area. A school and park, as well as numerous homes, are located in Shasta Lake City about four miles from Shasta Dam. Project activity would occur while school is in session, and the park is open to the public year round. Although Reclamation would implement measures to lessen the risk of hazardous materials exposure to sensitive receptors, this impact would be potentially significant for CP4 or CP4A.

This impact would be similar to Impacts Haz-4 (CP1) and Haz-4 (CP3), with additional measures for increasing habitat for anadromous fish. However, no additional actions are proposed that would affect the potential for the exposure of sensitive receptors to hazardous materials or hazardous waste.

This impact would be potentially significant for CP4. Mitigation for this impact is proposed in Section 9.3.5.

This impact would be potentially significant for CP4A. Mitigation for this impact is proposed in Section 9.3.5.

Lower Sacramento River and Delta and CVP/SWP Service Areas
Impact Haz-5 (CP4 and CP4A): Wildland Fire Risk No new facilities or project construction in the extended study area would affect the potential for wildland fire. Construction materials would be transported and workers would travel to the extended study area via I-5. However, the typical quick response to traffic accidents and fires ignited along roadways significantly decreases the potential for a wildland fire being accidentally ignited by project-related traffic. Therefore, this impact would be less than significant for CP4 or CP4A.

This impact would be similar to Impact Haz-5 (CP1). No new facilities or project construction would occur in the extended study area that would affect the existing potential for wildland fire. The potential for an increased risk of fire resulting from haul trucks or construction traffic associated with the project would be negligible.

Therefore, this impact would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

Therefore, this impact would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact Haz-6 (CP4 and CP4A): Release of Potentially Hazardous Materials or Hazardous Waste No new facilities or project construction in the extended study area would result in the release of hazardous material or waste. Transport of hazardous materials would be conducted in accordance with CCR Title 26 and would be licensed by the CHP, pursuant to California Vehicle Code Section 32000, which requires proper packaging and licensing by hazardous materials haulers and approved by Caltrans. Therefore, this impact would be less than significant for CP4 or CP4A.

This impact would be similar to Impact Haz-6 (CP1). No new facilities or project construction would occur in the extended study area that would result in the direct or indirect release of hazardous material or waste. The potential for an increased risk of hazardous materials spills resulting from haul trucks associated with the project would be negligible.

Therefore, this impact would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

Therefore, this impact would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact Haz-7 (CP4 and CP4A): Exposure of Workers to Hazardous Materials Project implementation would not result in new facilities or construction in the extended study area. Hazardous material transport and safety procedures for hazardous material transported through the extended study area would be sufficient to minimize risks to workers. Therefore, this impact would be less than significant for CP4 or CP4A.

This impact would be similar to Impact Haz-7 (CP1). Project implementation would not result in new facilities or construction in the extended study area. Workers involved in hazardous waste disposal activities would follow CalEPA and OSHA hazardous material and waste handling rules and regulations.

Therefore, this impact would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

Therefore, this impact would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact Haz-8 (CP4 and CP4A): Exposure of Sensitive Receptors to Hazardous Materials or Hazardous Waste No new facilities or project construction would occur in the extended study area that would directly or indirectly result in the exposure of sensitive receptors to hazardous materials or hazardous waste. Therefore, this impact would be less than significant for CP4 or CP4A.

This impact would be similar to Impact Haz-8 (CP1). No new facilities or project construction would occur in the extended study area that would result in the direct or indirect exposure of sensitive receptors to hazardous materials or hazardous waste. The potential for the exposure of sensitive receptors to hazard materials or waste associated with the project would be negligible.

Therefore, this impact would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

Therefore, this impact would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

CP5 – 18.5-Foot Dam Raise, Combination Plan

Shasta Lake and Vicinity and Upper Sacramento River (Shasta Dam to Red Bluff)

Impact Haz-1 (CP5): Wildland Fire Risk Project implementation could contribute to wildland fire risk. Project construction and operation, and the anticipated postconstruction human activity in the primary study area would increase the potential for fire ignition. Therefore, this impact would be potentially significant.

This impact would be similar to Impact Haz-1 (CP4 and CP4A). This impact would be potentially significant. Mitigation for this impact is proposed in Section 9.3.5.

Impact Haz-2 (CP5): Release of Potentially Hazardous Materials or Hazardous Waste Project construction and operation would involve the transportation, use, or storage of hazardous materials. Local, State, and Federal safety codes and procedures related to hazardous material transport, handling, and disposal would be followed for project construction and operation to minimize the risk of a hazardous materials release. However, an accidental release resulting from project activities could expose the public and the environment to a significant safety hazard. Therefore, this impact would be potentially significant.

This impact would be similar to Impact Haz-2 (CP4 and CP4A). Under CP5, the major components described for CP3 would be implemented, but as described under CP4 and CP4A, the project focus would be a combination of increasing water supply availability, enhancing environmental resources in the primary study area, and maintaining the existing level of recreational opportunities. No additional actions are proposed that would affect the potential for the release of hazardous materials or hazardous waste. This impact would be potentially significant. Mitigation for this impact is proposed in Section 9.3.5.

Impact Haz-3 (CP5): Exposure of Workers to Hazardous Materials Project implementation could result in the exposure of workers to hazardous materials. The project would require the use of potentially hazardous materials to operate construction equipment and to construct various facilities. Reclamation and project contractors would follow local, State, and Federal regulations and procedures for properly transporting, handling, and storing hazardous materials and hazardous waste to decrease the risk of exposure; however, there is a possibility of accidents that could expose project workers to hazardous materials. Structures proposed for demolition, such as bridges, may contain asbestos, lead paint, toxic wood preservatives, or other hazardous substances. Fuel tanks and utility infrastructure (e.g., transformers containing PCBs) proposed for relocation also would involve some risk of exposure to hazardous substances. However, at this time it appears that the quantities and types of hazardous materials and possible exposure levels to these materials in the workplace would not pose a significant risk to worker health and safety. Furthermore, there are no known hazardous waste sites in the primary study area. Therefore, this impact would be less than significant.

This impact would be similar to Impact Haz-3 (CP3). Under CP5, the major components described for CP3 would be implemented, but the project focus would be a combination of increasing water supply availability, enhancing environmental resources in the primary study area, and maintaining the existing level of recreational opportunities. No additional actions are proposed that would affect the potential for the exposure of workers to hazardous materials or hazardous waste. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Haz-4 (CP5): Exposure of Sensitive Receptors to Hazardous Materials Project implementation could expose sensitive receptors to hazardous materials and waste that would be transported through the primary study area. A school and park, as well as numerous homes, are located in Shasta Lake City about 4 miles from Shasta Dam. Project activity would occur while school is in session, and the park is open to the public year round. Although Reclamation would implement measures to lessen the risk of hazardous materials exposure to sensitive receptors, this impact would be potentially significant.

This impact would be similar to Impact Haz-4 (CP3). Under CP5, the major components described for CP3 would be implemented, but the project focus would be a combination of increasing water supply availability, enhancing environmental resources in the primary study area, and maintaining the existing level of recreational opportunities. No additional actions are proposed that would affect the potential for the exposure of sensitive receptors to hazardous materials or hazardous waste. This impact would be potentially significant. Mitigation for this impact is proposed in Section 9.3.5.

Lower Sacramento River and Delta and CVP/SWP Service Areas
Impact Haz-5 (CP5): Wildland Fire Risk No new facilities or project construction in the extended study area would affect the potential for wildland fire. Construction materials would be transported and workers would travel to the extended study area via I-5. However, the typical quick response to traffic accidents and fires ignited along roadways significantly decreases the potential for a wildland fire being accidentally ignited by project-related traffic. Therefore, this impact would be less than significant.

This impact would be similar to Impact Haz-5 (CP1). No new facilities or project construction would occur in the extended study area that would affect the existing potential for wildland fire. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Haz-6 (CP5): Release of Potentially Hazardous Materials or Hazardous Waste No new facilities or project construction in the extended study area would result in the release of hazardous material or waste. Transport of hazardous materials would be conducted in accordance with CCR Title 26 and would be licensed by the CHP, pursuant to California Vehicle Code Section 32000, which requires proper packaging and licensing by hazardous materials haulers and approved by Caltrans. Therefore, this impact would be less than significant.

This impact would be similar to Impact Haz-6 (CP1). No new facilities or project construction would occur in the extended study area that would result in the direct or indirect release of hazardous material or waste. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Haz-7 (CP5): Exposure of Workers to Hazardous Materials Project implementation would not result in new facilities or construction in the extended study area. Hazardous material transport and safety procedures for hazardous material transported through the extended study area would be sufficient to minimize risks to workers. Therefore, this impact would be less than significant.

This impact would be similar to Impact Haz-7 (CP1). Project implementation would not result in new facilities or construction in the extended study area. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Haz-8 (CP5): Exposure of Sensitive Receptors to Hazardous Materials or Hazardous Waste No new facilities or project construction would occur in the extended study area that would directly or indirectly result in the exposure of sensitive receptors to hazardous materials or hazardous waste. Therefore, this impact would be less than significant.

This impact would be similar to Impact Haz-8 (CP1). No new facilities or project construction would occur in the extended study area that would result in the direct or indirect exposure of sensitive receptors to hazardous materials or hazardous waste. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

9.3.5 Mitigation Measures

Table 9-1 presents a summary of mitigation measures for hazards and hazardous materials and waste.

Table 9-1. Summary of Mitigation Measures for Hazards and Hazardous Materials and Waste

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/ CP4A	CP5
Impact Haz-1: Wildland Fire Risk (Shasta Lake and Vicinity and Upper Sacramento River)	LOS before Mitigation	NI	PS	PS	PS	PS	PS
	Mitigation Measure	None required.	Mitigation Measure Haz-1: Coordinate and Assist Public Services Agencies to Reduce Fire Hazards.				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS
Impact Haz-2: Release of Potentially Hazardous Materials or Hazardous Waste (Shasta Lake and Vicinity and Upper Sacramento River)	LOS before Mitigation	NI	PS	PS	PS	PS	PS
	Mitigation Measure	None required.	Mitigation Measure Haz-2: Reduce Potential for Release of Hazardous Materials and Waste.				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS
Impact Haz-3: Exposure of Workers to Hazardous Materials (Shasta Lake and Vicinity and Upper Sacramento River)	LOS before Mitigation	NI	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS
Impact Haz-4: Exposure of Sensitive Receptors to Hazardous Materials (Shasta Lake and Vicinity and Upper Sacramento River)	LOS before Mitigation	NI	PS	PS	PS	PS	PS
	Mitigation Measure	None required.	Mitigation Measure Haz-4: Reduce Potential for Exposure of Sensitive Receptors to Hazardous Materials or Waste.				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS
Impact Haz-5: Wildland Fire Risk (Lower Sacramento River, Delta, CVP/SWP Service Areas)	LOS before Mitigation	NI	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS

Table 9-1. Summary of Mitigation Measures for Hazards and Hazardous Materials and Waste (contd.)

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/ CP4A	CP5
Impact Haz-6: Release of Potentially Hazardous Materials or Hazardous Waste (Lower Sacramento River, Delta, CVP/SWP Service Areas)	LOS before Mitigation	NI	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS
Impact Haz-7: Exposure of Workers to Hazardous Materials (Lower Sacramento River, Delta, CVP/SWP Service Areas)	LOS before Mitigation	NI	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS
Impact Haz-8: Exposure of Sensitive Receptors to Hazardous Materials (Lower Sacramento River, Delta, CVP/SWP Service Areas)	LOS before Mitigation	NI	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS

Key:
CP = Comprehensive Plan
CVP = Central Valley Project
LOS = level of significance
LTS = less than significant
NI = no impact
PS = potentially significant
SWP = State Water Project

No-Action Alternative

No mitigation measures are required for this alternative.

CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

No mitigation is required for Impact Haz-3 (CP1) or Impacts Haz-5 (CP1) through Haz-8 (CP1). Mitigation is provided below for other impacts of CP1 on hazards and hazardous materials. Mitigation is provided for the wildland fire hazard, the risk of hazardous material or hazardous waste releases, and the risk of exposing sensitive receptors to hazardous materials.

Mitigation Measure Haz-1 (CP1): Coordinate and Assist Public Services Agencies to Reduce Fire Hazards Reclamation will coordinate all proposed road closures, detours, and traffic control measures with SCSO and the Tehama County Sheriff’s Office, which are the designated offices of emergency services for the primary study area.

Reclamation will also coordinate all proposed road closures, detours, and traffic control measures with USFS, Caltrans, the CHP, the City of Shasta Lake, and the surrounding Shasta Lake communities.

Reclamation will appoint a public liaison to communicate construction schedules, road closures, and project activities with the public. The liaison will organize and conduct public meetings for communicating project information. The liaison will meet with all affected public services agencies to coordinate public meetings and information exchanges.

Reclamation will meet with public services agencies to determine that traffic controls for infrastructure, utility, and structure relocation do not impede emergency access for wildland fire response capabilities.

Reclamation will require that all project workers receive fire prevention safety training, which identifies local wildland fire hazards and informs workers of the relevant fire prevention procedures, rules, and regulations.

Implementation of this mitigation measure would reduce Impact Haz-1 (CP1) to a less-than-significant level.

Mitigation Measure Haz-2 (CP1): Reduce Potential for Release of Hazardous Materials and Waste Reclamation will update the Shasta Dam facilities HMBP (or like document). The update will provide information regarding the hazardous materials used for project implementation and hazardous waste that would be generated.

Reclamation will coordinate hazardous materials and waste information with SCSO and the Tehama County Sheriff’s Office (the designated offices of emergency services for the primary study area), USFS, the City of Shasta Lake, and the surrounding Shasta Lake communities. Transportation coordination efforts will also include the CHP and Caltrans, and will include disclosing and planning proposed hazardous material transportation routes to ensure use of the route(s) having the least impact.

Reclamation will appoint a public liaison to communicate hazardous material transportation routes related to project activities with the public. The liaison will organize and conduct public meetings, which will include discussions of hazardous waste transport in the primary and extended study areas. The liaison will meet with all affected public services agencies to coordinate public meetings and information exchanges.

Project workers who may come into contact with hazardous materials or waste will be required to receive hazardous material safety training, which identifies hazardous materials on the project site and informs workers of the relevant safety procedures, rules, and regulations that address hazardous waste handling, storage, and transportation.

Reclamation will ensure that project construction sites have staging areas that minimize potential hazardous waste releases and that meet best management practices for short-term construction site hazardous material storage.

Implementation of this mitigation measure would reduce Impact Haz-2 (CP1) to a less-than-significant level.

Mitigation Measure Haz-4 (CP1): Reduce Potential for Exposure of Sensitive Receptors to Hazardous Materials or Waste Reclamation will coordinate hazardous materials transportation routes with SCSO and the Tehama County Sheriff's Office (which are the designated offices of emergency services for the primary study area), USFS, Caltrans, CHP, the City of Shasta Lake, a representative from the Shasta Lake Elementary School, and other affected local agencies within the primary and extended study areas. Coordination efforts will include disclosing and planning proposed hazardous material transportation routes and schedules to allow for site-specific modifications that would lessen the potential impact on sensitive receptors.

Reclamation will appoint a public liaison to communicate hazardous material transportation routes related to project activities with the public. The liaison will organize and conduct public meetings, which will include a discussion of hazardous waste transport near local sensitive receptors. The liaison will meet with all affected public services agencies to coordinate public meetings and information exchanges.

Reclamation will identify sensitive receptor sites for all project workers who would use, handle, or transport hazardous materials, and require workers transporting hazardous materials past the sensitive receptors to proceed with extreme caution.

Reclamation will place road signs identifying sensitive receptor sites for hazardous material haulers and post reduced speed limits if local jurisdictions find it necessary to prevent potential impacts.

Implementation of this mitigation measure would reduce Impact Haz-4 (CP1) to a less-than-significant level.

CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

No mitigation is required for Impact Haz-3 (CP2) or Impacts Haz-5 (CP2) through Haz-8 (CP2). Mitigation is provided below for other impacts of CP2 on hazards and hazardous materials. Mitigation is provided for the wildland fire hazard, the risk of hazardous material or hazardous waste releases, and the risk of exposing sensitive receptors to hazardous materials.

Mitigation Measure Haz-1 (CP2): Coordinate and Assist Public Services Agencies to Reduce Fire Hazards This mitigation measure is identical to

Mitigation Measure Haz-1 (CP1). Implementation of this mitigation measure would reduce Impact Haz-1 (CP2) to a less-than-significant level.

Mitigation Measure Haz-2 (CP2): Reduce Potential for Release of Hazardous Materials and Waste This mitigation measure is identical to Mitigation Measure Haz-2 (CP1). Implementation of this mitigation measure would reduce Impact Haz-2 (CP2) to a less-than-significant level.

Mitigation Measure Haz-4 (CP2): Reduce Potential for Exposure of Sensitive Receptors to Hazardous Materials or Waste This mitigation measure is identical to Mitigation Measure Haz-4 (CP1). Implementation of this mitigation measure would reduce Impact Haz-4 (CP2) to a less-than-significant level.

CP3 – 18.5-Foot Dam Raise, Agricultural Water Supply Reliability and Anadromous Fish Survival

No mitigation is required for Impact Haz-3 (CP3) or Impacts Haz-5 (CP3) through Haz-8 (CP3). Mitigation is provided below for other impacts of CP3 on hazards and hazardous materials. Mitigation is provided for the wildland fire hazard, the risk of hazardous material or hazardous waste releases, and the risk of exposing sensitive receptors to hazardous materials.

Mitigation Measure Haz-1 (CP3): Coordinate and Assist Public Services Agencies to Reduce Fire Hazards This mitigation measure is identical to Mitigation Measure Haz-1 (CP1). Implementation of this mitigation measure would reduce Impact Haz-1 (CP3) to a less-than-significant level.

Mitigation Measure Haz-2 (CP3): Reduce Potential for Release of Hazardous Materials and Waste This mitigation measure is identical to Mitigation Measure Haz-2 (CP1). Implementation of this mitigation measure would reduce Impact Haz-2 (CP3) to a less-than-significant level.

Mitigation Measure Haz-4 (CP3): Reduce Potential for Exposure of Sensitive Receptors to Hazardous Materials or Waste This mitigation measure is identical to Mitigation Measure Haz-4 (CP1). Implementation of this mitigation measure would reduce Impact Haz-4 (CP3) to a less-than-significant level.

CP4 and CP4A – 18.5-Foot Dam Raise, Anadromous Fish Focus with Water Supply Reliability

No mitigation is required for Impact Haz-3 (CP4 and CP4A) or Impacts Haz-5 (CP4 and CP4A) through Haz-8 (CP4 and CP4A). Mitigation is provided below for other impacts of CP4 or CP4A on hazards and hazardous materials. Mitigation is provided for the wildland fire hazard, the risk of hazardous material or hazardous waste releases, and the risk of exposing sensitive receptors to hazardous materials.

Mitigation Measure Haz-1 (CP4 and CP4A): Coordinate and Assist Public Services Agencies to Reduce Fire Hazards This mitigation measure is identical to Mitigation Measure Haz-1 (CP1). Implementation of this mitigation measure would reduce Impact Haz-1 (CP4 and CP4A) to a less-than-significant level.

Mitigation Measure Haz-2 (CP4 and CP4A): Reduce Potential for Release of Hazardous Materials and Waste This mitigation measure is identical to Mitigation Measure Haz-2 (CP1). Implementation of this mitigation measure would reduce Impact Haz-2 (CP4 and CP4A) to a less-than-significant level.

Mitigation Measure Haz-4 (CP4 and CP4A): Reduce Potential for Exposure of Sensitive Receptors to Hazardous Materials or Waste This mitigation measure is identical to Mitigation Measure Haz-4 (CP1). Implementation of this mitigation measure would reduce Impact Haz-4 (CP4 and CP4A) to a less-than-significant level.

CP5 – 18.5-Foot Dam Raise, Combination Plan

No mitigation is required for Impact Haz-3 (CP5) or Impacts Haz-5 (CP5) through Haz-8 (CP5). Mitigation is provided below for other impacts of CP5 on hazards and hazardous materials. Mitigation is provided for the wildland fire hazard, the risk of hazardous material or hazardous waste releases, and the risk of exposing sensitive receptors to hazardous materials.

Mitigation Measure Haz-1 (CP5): Coordinate and Assist Public Services Agencies to Reduce Fire Hazards This mitigation measure is identical to Mitigation Measure Haz-1 (CP1). Implementation of this mitigation measure would reduce Impact Haz-1 (CP5) to a less-than-significant level.

Mitigation Measure Haz-2 (CP5): Reduce Potential for Release of Hazardous Materials and Waste This mitigation measure is identical to Mitigation Measure Haz-2 (CP1). Implementation of this mitigation measure would reduce Impact Haz-2 (CP5) to a less-than-significant level.

Mitigation Measure Haz-4 (CP5): Reduce Potential for Exposure of Sensitive Receptors to Hazardous Materials or Waste This mitigation measure is identical to Mitigation Measure Haz-4 (CP1). Implementation of this mitigation measure would reduce Impact Haz-4 (CP5) to a less-than-significant level.

9.3.6 Cumulative Effects

Chapter 3, “Considerations for Describing the Affected Environment and Environmental Consequences,” discusses overall cumulative impacts methodology related to the action alternatives, including the relationship to the CALFED Bay-Delta Program Programmatic EIS/EIR cumulative impacts analysis, qualitative and quantitative assessment, past and future actions in the study area, and significance criteria.. Table 3-1, “Present and Reasonably

Foreseeable Future Actions Included in the Analysis of Cumulative Impacts, by Resource Area," in Chapter 3, lists the present and reasonably foreseeable future projects considered quantitatively and qualitatively within the cumulative impacts analysis. This cumulative impacts analysis accounts for potential project impacts combined with the impacts of existing facilities, conditions, land uses, and reasonably foreseeable actions expected to occur in the study area on a qualitative and quantitative level.

Past projects and activities that have affected hazardous materials, potential exposure of sensitive receptors to hazardous materials or hazardous waste, and wildland fire risk in the study area are land use development, recreation activities, construction activities and accidental spills of hazardous materials.

The action alternatives would not combine with any of the quantitatively assessed projects listed in Table 3-1 to have a cumulatively considerable impact related to hazards or hazardous materials and waste; therefore, this section evaluates only those projects listed in Table 3-1 that are qualitatively considered in this EIS.

Potentially significant effects for SLWRI were identified in the areas of increased wildland fire risk, accidental releases of hazardous materials or hazardous waste, and potential exposure of sensitive receptors to hazardous materials or hazardous waste. The potential effects would be of greater magnitude and duration with the larger dam raises (i.e., CP3 through CP5 would have greater potential effects than CP1 and CP2).

Reasonably foreseeable actions in the Shasta Lake and vicinity area, such as the construction of Antlers Bridge or the Iron Mountain Mine Restoration Plan, may result in increased potential for wildland fire hazards or accidental releases of hazardous materials or hazardous waste within the primary study area. In addition, as described in the Climate Change Modeling Appendix, climate change could result in less precipitation through the 2050s and warmer air temperature, thereby increasing the risk of wildland fire hazard near Shasta Lake.

Implementation of the proposed SLWRI alternatives would result in potentially significant impacts to wildland fire hazards, accidental releases of hazardous materials or hazardous waste, and exposure of sensitive receptors to hazardous materials or hazardous waste. Additive and interactive/multiplicative effects of implementing the proposed SLWRI alternatives with past, present, and reasonably foreseeable probable future projects could result in cumulatively considerable impacts. However, mitigation would be implemented to reduce impacts associated with the project to a less-than-significant level. Therefore, the potential for project-related impacts to be cumulatively considerable after mitigation would be less than significant.

The exposure of workers to hazards, hazardous materials, or hazardous waste would not be a cumulatively considerable effect. Implementation of the proposed SLWRI alternatives would not be likely to involve the same workers or occur in the same place or time as other reasonably foreseeable actions. Therefore, project implementation would not likely be associated with significant cumulative effects in terms of exposing workers and other sensitive receptors to hazards, hazardous materials, or hazardous waste.

This page left blank intentionally.

Chapter 10
Agriculture and Important Farmland

10.1 Affected Environment

This section describes the affected environment related to existing agricultural land uses, Important Farmland, Williamson Act contract lands, and forest resources in the primary and extended study areas. See Chapter 12, "Botanical Resources and Wetlands," for detailed definitions of forest land habitats and Chapter 13, "Wildlife Resources," for a discussion of the relationship between agricultural land uses and wildlife uses. See Chapter 17, "Land Use and Planning," for a discussion of existing land uses within the primary and extended study areas and the project's consistency with existing land uses.

10.1.1 Agriculture

Shasta Lake and Vicinity

The setting for agricultural resources in the Shasta Lake and vicinity portion of the primary study area consists of areas in Shasta County north of Shasta Dam, including lands surrounding the lake, that would be subject to inundation and areas where infrastructure would be removed, modified, or relocated under the action alternatives.

Shasta Lake is surrounded by mountainous and rugged terrain. There are no known agricultural uses adjacent to the lake or in its immediate vicinity above Shasta Dam.

Upper Sacramento River (Shasta Dam to Red Bluff)

The upper Sacramento River portion of the primary study area consists of the portion of Shasta County south of Shasta Dam and downstream to Red Bluff in Tehama County. The valleys of the Sacramento River and its tributaries (Churn, Cottonwood, Anderson, Stillwater, Cow, Bear, Battle, and Clover creeks) contain some of the most productive agricultural land in Shasta and Tehama counties. In addition to the high quality of their soils, agricultural lands in this area enjoy a long growing season of 172 to 205 days. Water from the Anderson-Cottonwood Irrigation District (ACID), surface diversions of streams, or groundwater is available and good transportation access exists (Shasta County 2004). As of 2007, Shasta County's 1,473 farms encompassed a total of almost 390,812 acres and Tehama County's 1,752 farms were located on 532,206 acres (USDA 2007a, 2007b). About 253,000 acres of Important Farmland are located in the Sacramento River corridor between Shasta Dam and the Red Bluff

Pumping Plant. Please see Section 10.1.2, "Important Farmland," below for further discussion.

The majority of agricultural activity is located on the Sacramento Valley floor in the south-central portion of Shasta County and across central Tehama County. Small pockets of pastureland exist throughout Shasta County, including mountainous regions. Based on production value, the largest use of agricultural land in Shasta County is field crops, followed by livestock (Shasta County 2011). Nursery stock is the third largest use. Approximately 13 percent of Shasta County land is devoted to some type of agricultural use.

Agricultural uses in the Tehama County portion of the Sacramento Valley consist mostly of orchard and nursery plant operations. The primary crops of Tehama County orchards are walnuts, prunes, almonds, and olives. These crops are largely concentrated in the floodplain alongside the Sacramento River (within and below the upper Sacramento River portion of the primary study area) and are irrigated with groundwater, as well as surface water from local creek diversions and the Sacramento River.

A drastic increase in orchard acreage has occurred since orchard production was initially reported by the National Agricultural Statistics Service in 1930. A combination of factors is responsible for this increase: the availability of irrigation water, advances in irrigation technologies, relatively good commodity prices for orchard crops, and the availability of processing facilities.

The upper Sacramento River portion of the primary study area (areas below Shasta Dam) is largely serviced by ACID. ACID's service area of approximately 32,000 acres extends south from the city of Redding in Shasta County into northern Tehama County. ACID does not provide water for municipal and industrial uses in these areas. Approximately 90 percent of ACID's customers irrigate pasture for haying or livestock; however, in most of the river corridor the water is used to irrigate orchard and other food crops. In total, ACID's service area accounts for about two-thirds of all irrigated pasture in the Redding basin.

ACID uses a rotation schedule to deliver irrigation water to its customers. Very little groundwater is used within the district for agricultural purposes, except occasionally during drought years. Water requirements are typically highest during summer (June, July, and August) because of the area's hot, dry climate. A groundwater management program is being developed; by 2005, 12 dual-completion groundwater monitoring wells had been installed within ACID boundaries. The small portion of groundwater used is limited primarily to deciduous crops and is pumped by privately owned wells. ACID's facilities and irrigation are important contributors to groundwater recharge in the Redding basin. Annual seepage associated with the ACID Main Canal is estimated to be approximately 44,000 acre-feet.

Agricultural use within ACID's service area is primarily pasture, in addition to alfalfa and some deciduous orchard crops. Pasture use is typically in the range of 75 percent of the total crop mix served by ACID. Annual cropping patterns have not varied substantially since the mid-1970s. Therefore, associated on-field water requirements and diversions for crops have been more a function of water-year type and climate than changes in cropping.

Agriculture thus accounts for an important segment of the economic base of Shasta and Tehama counties. In 2011, for example, the total market value of farm products in Shasta County was $76,328,000, a slight increase from the $70,760,000 produced in 2010. Minor increases in the annual production value of orchard crops and apiary products accounted for this increase. Field crops accounted for nearly 46 percent of this total, with livestock sales providing nearly one-third (32.2 percent) of the county's total agricultural production value. In 2010, Shasta County ranked only 37th among the 58 California counties in the value of total agricultural production – $110,283,000, as reported by the California Department of Food and Agriculture (Shasta County 2011).

In addition to its economic contribution, the agriculture industry is in large part responsible for the rural character of Shasta and Tehama counties. Farmland can also play an important role in the support of wildlife values through the effects it has on conservation of wildlife habitats. As more farmland is developed for urban and suburban uses, the available habitat for most field and woodland edge species decreases, resulting in a subsequent decline in or potential elimination of their populations. Agricultural lands also provide productive, privately maintained open space that contributes to the open, natural landscape of much of Shasta and Tehama counties.

Lower Sacramento River and Delta

The Sacramento River below the Red Bluff Pumping Plant and the river's tributaries continue to provide water to crops grown in the river's floodplain and the valley floor, which broadens as it expands into the Central Valley. The Sacramento River crosses Tehama, Butte, Glenn, Colusa, Sutter, Yolo, and Sacramento counties and is an important source of water for the irrigation and agricultural districts in those counties.

California's Central Valley is home to more than 4 million people; agriculture is the most important segment of the region's robust economy. The Sacramento and San Joaquin river basins provide drinking water for more than two-thirds of Californians and irrigation water for California's crops. The availability of irrigation water makes the Central Valley a major source of reliable, high-quality crops, such as almonds, walnuts, grapes, tomatoes, rice, and other orchard, vineyard, and field crops, marketed to the nation and the world (Reclamation and DWR 2005; DWR and Reclamation 2006).

As of 2007, California's 81,033 farms included a total of 25.4 million acres (USDA 2007c). Of that acreage, the Sacramento Valley had more than 11,000 farms with about 4.3 million acres. Sacramento Valley portions of the Central Valley's watersheds support a wide variety of agricultural uses, including livestock grazing, irrigated grain and vegetable crops, and orchards (DWR and Reclamation 2006).

Most agricultural water demands in the Sacramento Valley are met in average water years. Farmers have been growing more crops per acre-foot of applied water by improving productivity and efficiency. However, in some areas, water sources once used for agriculture are now used for urban needs, environmental restoration, and groundwater replenishment. During droughts, water supplies are less reliable, heightening competition and at times leading to conflicts among water users. Water quality is degraded, making it difficult and costly to make the water drinkable. Irrigated agriculture and related businesses are adversely affected, in turn affecting California's economy. During droughts, groundwater levels decline, pumping costs increase, and many rural residents who depend on small water systems or wells run short of water (DWR and Reclamation 2006).

Table 10-1 provides examples of water supply distribution among uses in wet, above-normal, and dry years.[1] Delta agricultural lands were "reclaimed" when levees were constructed and marshy areas were drained. In less than 100 years, from 1850 to 1930, hundreds of thousands of acres of land went into agricultural production. Historically, asparagus, corn, alfalfa, and sugar beets were the Delta's dominant crops. However, a wide variety of crops have been grown in the Delta. In 2008, the Delta's main crops were corn, alfalfa, tomatoes, and wine grapes (DWR 2009).

[1] Throughout this document, water year types are defined according to the Sacramento Valley Index Water Year Hydrologic Classification unless specified otherwise.

Table 10-1. California Water Balance Summary for Wet, Above-Normal, and Dry Years

Category	State Summary (MAF)			Sacramento River (TAF)			San Joaquin River (TAF)		
	1998 (171%)[1]	**2000 (97%)[1]**	**2001 (72%)[1]**	**1998 (168%)[1]**	**2000 (105%)[1]**	**2001 (67%)[1]**	**1998 (171%)[1]**	**2000 (97%)[1]**	**2001 (72%)[1]**
Total Supply (Precipitation and Imports)	336.9	194.7	145.5	90,351	58,217	36,564	40,727	28,497	20,010
Total Uses, Outflows, and Evaporation	331.1	200.5	159.8	86,859	59,469	40,124	38,922	28,527	22,707
Net Storage Changes in State	**5.8**	**-5.8**	**-14.3**	**3,492**	**-1,252**	**-3,560**	**1,805**	**-30**	**-2,697**
Distribution of Dedicated Supply (Includes Reuse) to Various Applied Water Uses									
Urban Uses	7.8	8.9	8.6	727.3	859.6	877.2	562.5	594.0	622.8
	(8%)	(11%)	(13%)	(3%)	(4%)	(5%)	(5%)	(5%)	(6%)
Agricultural Uses	27.3	34.2	33.7	6,458.2	8,713.9	8,567.1	5,458.1	7,034.1	7,154.2
	(29%)	(41%)	(52%)	(27%)	(38%)	(45%)	(47%)	(57%)	(67%)
Environmental Water [2]	59.4	39.4	22.5	16,397.8	13.487.6	9,587.7	5,604.5	4,637.1	2.930.1
	(63%)	(48%)	(35%)	(70%)	(58%)	(50%)	(48%)	(38%)	(27%)
Total Dedicated Supply	**94.5**	**82.5**	**64.8**	**23,583.3**	**23,061.1**	**19,032.0**	**11,625.1**	**12,265.2**	**10,707.1**

Source: DWR and Reclamation 2006

Notes:

[1] Percentage of normal precipitation. Water year 1998 was classified as a wet water year; 2000 was an above-normal water year; 2001 was a dry water year.

[2] Environmental water includes instream flows, wild and scenic river flows, required Delta outflow, and managed wetlands water use. Some environmental water is reused by agricultural and urban water users.

Key:

% = percent

DWR = California Department of Water Resources

MAF = million acre-feet

Reclamation = U.S. Department of Interior, Bureau of Reclamation

TAF = thousand acre-feet

CVP/SWP Service Areas

The CVP is the largest water storage and delivery system in California, covering 29 of the State of California's (State) 58 counties. Operated by Reclamation, the CVP consists of 21 reservoirs capable of storing 12 million acre-feet (MAF) of water, 11 powerplants, 500 miles of major canals and aqueducts, and many tunnels, conduits, and power transmission lines. The CVP irrigates about 3.25 million acres of farmland and supplies water to more than 2 million people through more than 250 water districts, individuals, and companies through water service contracts, Sacramento River water rights, and San Joaquin River exchange contracts. Most of the CVP service area is inside the Central Valley. About 90 percent of the south-of-Delta contractual delivery is for agricultural uses (Reclamation 2007).

The CVP plays a key role in California's economy, providing water for 6 of the top 10 agricultural counties in the nation's top farming state. The CVP provides about 5 MAF of water for farms, which is enough to irrigate about 3 million acres, or approximately one-third of the agricultural land in California (Reclamation 2009).

Most of the population of the CVP service area is concentrated in urban areas. The CVP service area includes various municipal and industrial water contractors and water districts that serve portions of the Sacramento and Stockton metropolitan areas and the San Francisco Bay Area (Reclamation 2007).

Outside of the fast-growing population centers, most of the CVP service area is rural, with irrigated agriculture being the predominant land use and driver of the local and regional economies (Reclamation 2007). As California's population continues to grow at a notable pace, water and power supplies have become more scarce and expensive; as a result, existing supplies have become more valuable.

Through contracts with 29 water agencies, the SWP provides water to Butte, Solano, Kings, and Kern counties in the Central Valley; to several Southern California counties; to Alameda and Santa Clara counties in the south San Francisco Bay Area; and to Napa and Solano counties in the north San Francisco Bay Area. In addition, the SWP provides water rights deliveries to water rights holders along the Feather River (Butte and Plumas counties). Of the total water delivered throughout California, the SWP provides water to about 600,000 acres of farmland. The SWP supplies about 10 percent of the total agricultural water used in the extended study area (DWR 2011).

Local surface water supplies (those not delivered by either the CVP or SWP) provide about 40 percent of all agricultural water used in the extended study area. More local surface water supplies are available on the east side of the valley because of the larger amount of precipitation in the Sierra Nevada. Locally owned water projects are especially important on the Yuba, Stanislaus, Tuolumne, Kings, and Merced rivers; but local sources on the west side, such as the Federal Solano Project, also are important.

As surface water flows through the San Joaquin Valley, numerous turnouts convey the water to farmland within the service areas of the SWP and CVP. The remaining water conveyed by the California Aqueduct is delivered to Southern California, home to about two-thirds of California's population (DWR 2011).

Groundwater provides an important supply of water for agriculture in normal years and often is used to reduce or eliminate shortages of surface water supplies during drought years. On average, groundwater provides about 20 percent of the total agricultural water used in the extended study area. Declining groundwater tables, subsidence, and loss of aquifer storage continue to be costly problems, particularly in the western and southern parts of the San Joaquin River region and the San Francisco Bay region, where less surface water is available.

10.1.2 Important Farmland

Important Farmland is classified by the California Department of Conservation (DOC) as Prime Farmland, Farmland of Statewide Importance, Unique Farmland, and Farmland of Local Importance (see Section 10.2, "Regulatory Framework," for further discussion). The following discussion of Important Farmland is derived from DOC's *California Farmland Conversion Report 2006–2008*, published in January 2011 (DOC 2011).

In 2008, DOC estimated that California had approximately 31.6 million acres of agricultural land, of which approximately 12.4 million acres were identified as Important Farmland and 19.2 million acres were identified as Grazing Land. During the 12 biennial reporting cycles since DOC's Farmland Mapping and Monitoring Program (FMMP) was established, more than 1.3 million acres of agricultural land in California have been converted to nonagricultural purposes.

Losses of irrigated farmland (Prime Farmland, Farmland of Statewide Importance, and Unique Farmland) have accelerated, as shown in updates to Important Farmland maps. Irrigated farmland decreased by 203,000 acres in 2008, a 30 percent greater decrease than in 2006. Idling of irrigated farmland became a major factor in 2008, exceeding the effect of urbanization for the first time in FMMP history. Losses of irrigated farmland have resulted in part from two factors: (1) drought-related reductions in water supply and (2) reclassification to Grazing Land or Farmland of Local Importance of those lands left idle for three or more update cycles, some of which may have been idled in anticipation of development.

Urban development decreased by 29 percent relative to the 2004–2006 period and the 2008 urbanization rate was the lowest rate recorded since the late 1990s. Nonetheless, between 2006 and 2008, 72,300 acres of agricultural land in the State were lost to urbanization, with irrigated farmland making up 20,400 acres, or 28 percent of all new urban land. Housing developments were the most frequent and largest category of newly urbanized land. The increase was associated mostly with construction of single-family homes at the periphery of existing cities, and to a lesser degree, with construction of apartment complexes. Retail and commercial developments and community infrastructure supporting new residential development also contributed substantially to urbanization.

The vast majority of the Important Farmland in California is located in the Central Valley, fed by the Sacramento and San Joaquin rivers and their tributaries.

Shasta Lake and Vicinity

According to the Shasta County Important Farmland map, published by DOC's Division of Land Resource Protection, no lands adjacent to Shasta Lake or in the immediate vicinity above Shasta Dam are designated as Important Farmland (Figure 10-1).

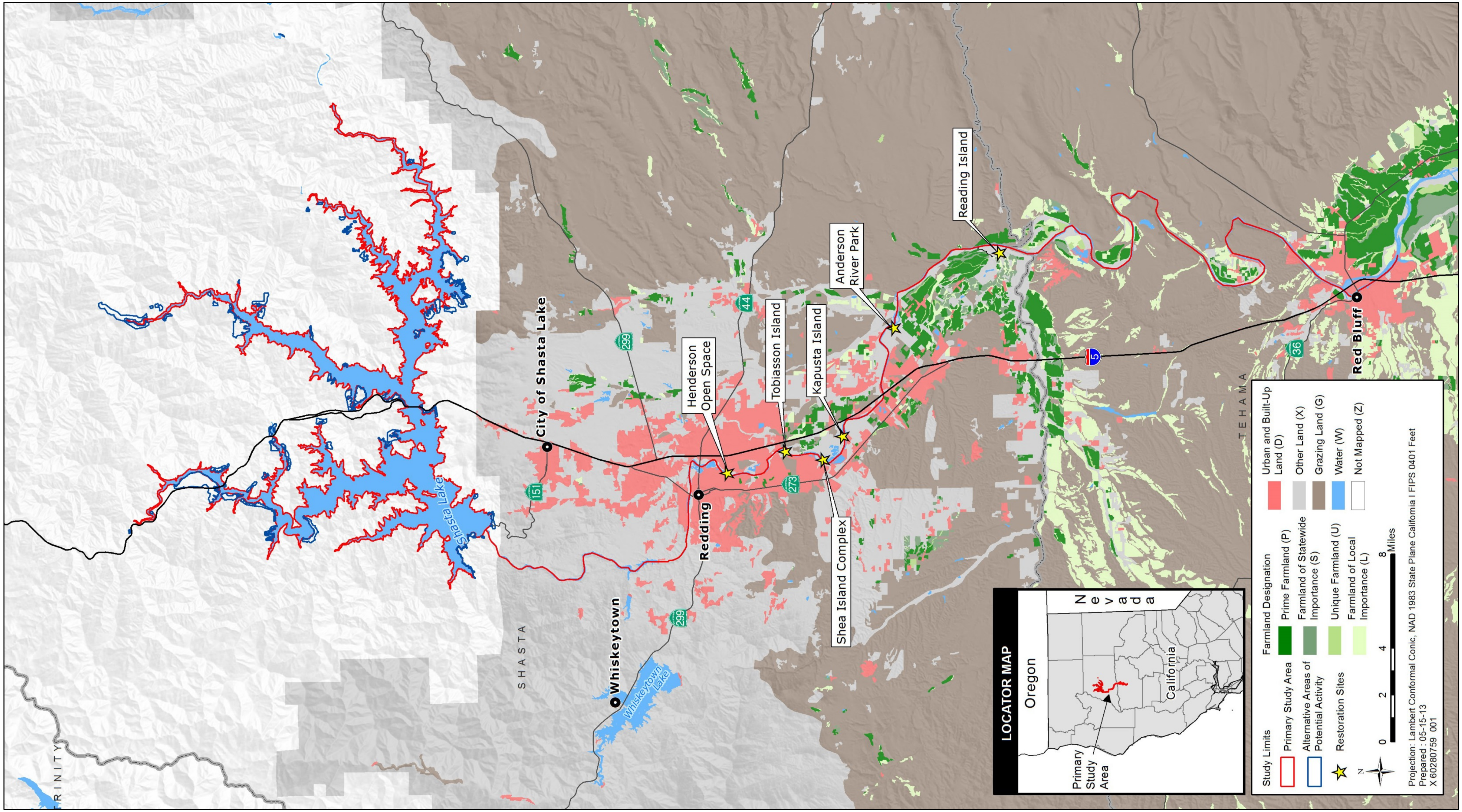


Figure 10-1. Important Farmland in the Primary Study Area

This page left blank intentionally.

Upper Sacramento River (Shasta Dam to Red Bluff)

The majority of Important Farmland in the primary study area is clustered in the former floodplain of the Sacramento River. As of 2008, Shasta County had 22,191 acres and Tehama County had 230,932 acres of Important Farmland (Table 10-2). The potential restoration and gravel augmentation sites described as part of CP4, CP4A, and CP5 are not located on Important Farmland.

Table 10-2. Acreage of Important Farmland in Shasta and Tehama Counties

Important Farmland Category	Shasta County	Tehama County	Total
Prime Farmland	12,290	63,037	75,327
Farmland of Statewide Importance	3,288	17,232	20,520
Unique Farmland	510	18,055	18,565
Farmland of Local Importance	6,103	132,608	138,711
Total	**22,191**	**230,932**	**253,123**

Source: DOC 2011

Key:
DOC = California Department of Conservation

According to the Important Farmland maps for Shasta and Tehama counties, the primary study area includes 432 acres of Important Farmland. Of this total, 90 acres are located in Shasta County and 342 acres are located in Tehama County (Table 10-3).

Table 10-3. Acreage of Important Farmland in Portions of Shasta and Tehama Counties Within the Primary Study Area

Important Farmland Category	Shasta County	Tehama County	Total
Prime Farmland	69	30	99
Farmland of Statewide Importance	8	–	8
Unique Farmland	8	38	46
Farmland of Local Importance	5	274	279
Total	**90**	**342**	**432**

Source: DOC 2010a

Key:
DOC = California Department of Conservation

Lower Sacramento River and Delta

Urbanization in the Sacramento Valley between 2006 and 2008 resulted in a decrease of 5,300 acres of irrigated farmland, which accounted for 33 percent of the statewide net decrease. Housing was the largest component of new urban acreage in the lower Sacramento River portion of the extended study area. Most of the increase was associated with single-family homes located at the periphery of existing cities, retail and commercial developments, and community infrastructure supporting new residential development. It is anticipated that current and future population growth will increase the demand for developable land, particularly near the Bay Area, Stockton, and Sacramento. This demand results in the conversion of open space, primarily agricultural land, to residential and commercial uses.

Overall, the Sacramento Valley saw the largest drop in urbanization between 2006 and 2008—63 percent—with a rate that fell below that of the San Francisco Bay Area for the first time since 2002. Much of this decrease was caused by the slowdown in Sacramento County's growth between the two updates. While urbanization in the Sacramento Valley dropped substantially, ecological restoration remained a factor. Most wetland restoration projects in the region were adjacent to existing wildlife refuges and river channels.

Other factors besides conversion to urban or other land uses (e.g., habitat restoration) also affect the acreage of irrigated farmland. Regionally, complex factors related to availability of surface and groundwater supplies, crop markets, and anticipation of urban development affect the acreage of irrigated farmland. More locally, changes in annual water supplies, drainage, access, and compatibility with adjacent land uses also affect the productivity and value, and thus use, of agricultural land. Potential conflicts of adjacent land uses with agricultural production include traffic, vandalism, dumping, and provision of habitat for pest organisms (EDAW 2006; Sokolow et al. 2010).

The periphery of the Delta is undergoing rapid urbanization associated with substantial population growth. In 2008, declines of irrigated farmland in the Delta occurred primarily in Contra Costa and Solano counties, as each lost more than 4,100 acres of irrigated land during the update. Urbanization accounted for more than half the decrease in Contra Costa County, while Solano County was affected by restoration projects in the south county (Liberty Island area) and land idling near Vacaville. Between 2000 and 2008, about 75,000 acres of agricultural land in the Delta were converted to urban and conservation uses. As of 2008, approximately 550,100 acres of Important Farmland were located in the Delta.

CVP/SWP Service Areas

Declines in Important Farmland in the CVP/SWP service areas have been similar to those discussed above for the lower Sacramento River and Delta. Urbanization was responsible for 77 percent (55,670 acres) of the total losses of Important Farmland in the CVP/SWP service areas between 2006 and 2008. Twenty-one percent of the newly developed land in the CVP/SWP service areas was located in Riverside County alone. Southern California led all regions with 50 percent of the developed acres, while the San Joaquin Valley ranked second at 27 percent of the total. Overall, both regions showed a decline in urbanization relative to the 2004–2006 period. Southern California's decrease was larger—24 percent compared to the 17-percent drop in urbanization in the San Joaquin Valley.

In addition, the San Joaquin Valley lost 66 percent of its irrigated farmland to long-term land idling in Fresno, Kings, and Kern counties. The Fresno County decrease—more than 56,000 acres—was particularly notable and is associated with salinity and drought-related land retirement on the west side of the valley.

10.1.3 Williamson Act

As of January 1, 2008, 16.6 million acres were enrolled under the Williamson Act statewide. (Figure 10-2 shows Williamson Act lands in the primary study area.) This represents approximately half of California's farmland and nearly one-third of its privately owned land. The nonrenewal process is the most common mechanism for terminating Williamson Act contracts. Nonrenewal trends may be seen as an indicator of likely farmland conversion in particular locations. Statewide, nonrenewal initiations have increased each year since 2001 and reached a new high in 2007, with the San Joaquin Valley accounting for the largest increase in nonrenewal initiations. Overall, a total of 520,550 acres of contracted land was at some stage of the nonrenewal process in 2008 (DOC 2009, 2010b).

10.1.4 Forest Land

Forest land is defined as native tree cover greater than 10 percent that allows for management of timber, aesthetics, fish and wildlife, recreation, and other public benefits (California Public Resources Code (PRC) Section 12220(g)). Natural forest and woodland vegetation types in the study area typically have greater than 10 percent cover by native trees. (Figures 12-2a through 12-2f in Chapter 12, "Botanical Resources and Wetlands," display the distribution of natural forest and woodland vegetation.)

Forests serve as high-quality habitat for fish and wildlife species, sequester carbon to mitigate effects of climate change, capture vital runoff for agricultural and domestic water supply, and provide a variety of outdoor recreation and education opportunities. Many rural communities depend on income and employment opportunities that result from working timber industries or on amenity values to attract new residents seeking a better lifestyle. In metropolitan areas, urban forests contribute to improved air quality, cooling of heat islands for energy conservation, and local employment (Cal Fire 2010).

This page left blank intentionally.

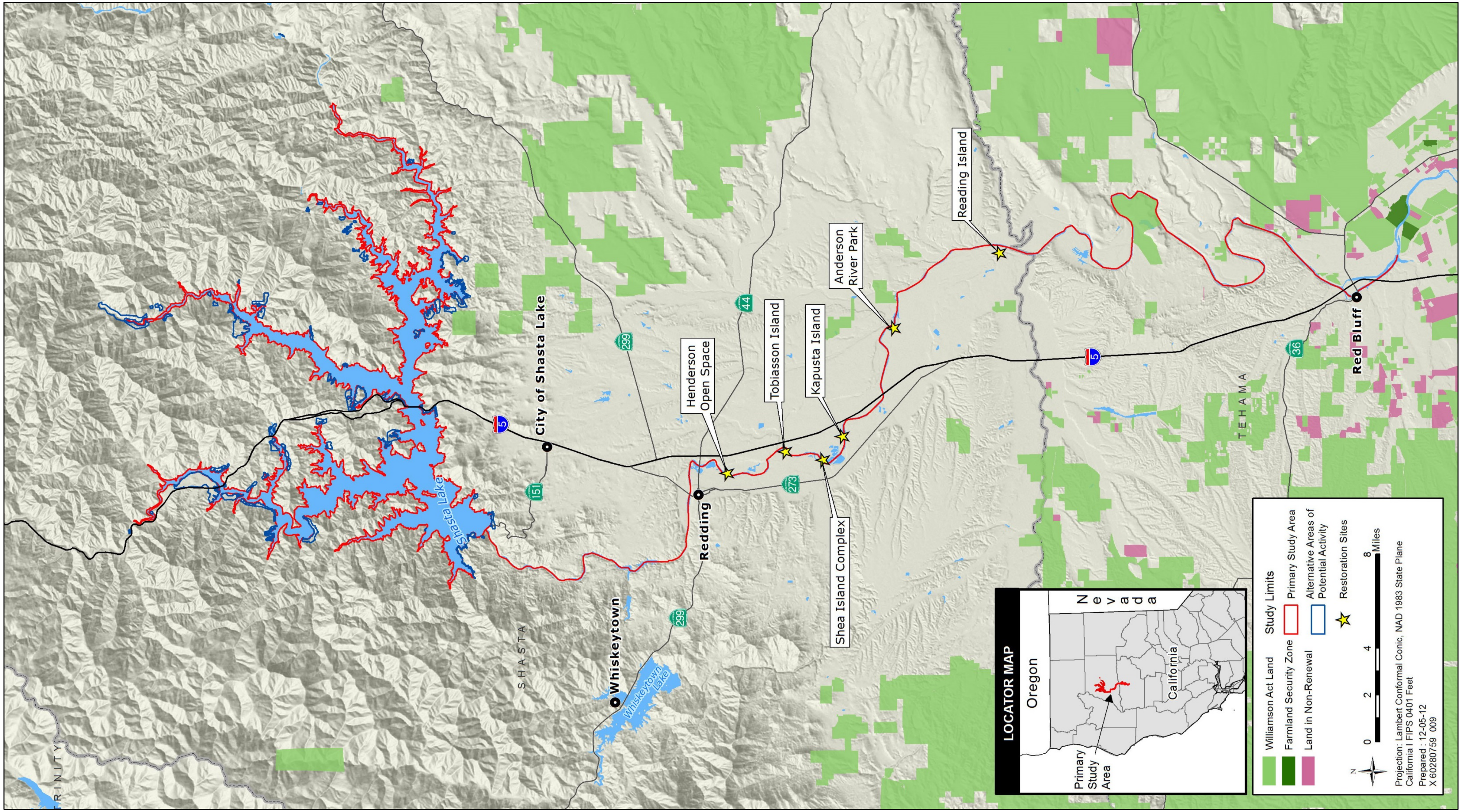


Figure 10-2. Williamson Act Lands in the Primary Study Area

This page left blank intentionally.

Shasta Lake and Vicinity

The study area for forest resources in the Shasta Lake and vicinity portion of the primary study area consists of the *impoundment areas* and the *relocation areas*. The impoundment areas are the areas that would be subject to inundation by the five arms and Main Body of Shasta Lake under the proposed dam enlargement scenarios. The relocation areas are those areas proposed as relocation sites for roadways, bridges, utilities, marinas, and campgrounds that could be inundated after the enlargement of Shasta Dam, as well as proposed dike locations.

The impoundment areas and relocation areas are characterized by a variety of forest lands typical of transitional mixed woodland and low-elevation forests: blue oak woodland, Brewer's oak, California black oak forest, canyon live oak forest, Fremont cottonwood forest, ghost pine woodland, interior live oak woodland, knobcone pine forest, Oregon white oak woodland, ponderosa pine-Douglas fir forest, ponderosa pine forest, and valley oak woodland (see Figures 12-2a through 12-2f and Table 12-1 in Chapter 12, "Botanical Resources and Wetlands"). As discussed in Chapter 12, "Botanical Resources and Wetlands," approximately 4,675 acres of forest land in the impoundment areas and relocation areas could potentially be affected by the alternatives (Table 10-4).

The exact combination of vegetation varies, with dramatic changes often occurring in relation to aspect, slope, geologic substrate, or juxtaposition with other habitats.

Table 10-4. Maximum Amount of Forest Land in the Impoundment and Relocation Areas

Forest Land	Area (Acres)
Blue oak woodland	11
Brewer oak scrub	151
California black oak forest	663
Canyon live oak forest	408
Fremont cottonwood forest	<1
Ghost pine woodland	456
Interior live oak woodland	6
Knobcone pine forest	293
Oregon white oak woodland	8
Ponderosa pine-Douglas fir forest	502
Ponderosa pine forest	2,176
Valley oak woodland	1
Total	**4,675**

Key:
< = less than

Upper Sacramento River (Shasta Dam to Red Bluff)

Forest land in the upper Sacramento River portion of the primary study area consists of riparian forest and oak woodland and savanna. Oak woodlands present in the primary study area include blue oak woodland, blue oak savanna, foothill pine-oak woodland, and valley oak woodland. Much of the Sacramento River from Shasta Dam to Redding is deeply entrenched in bedrock, which precludes development of extensive areas of riparian vegetation. The river corridor between Redding and Red Bluff, however, still maintains extensive areas of riparian forest communities.

Riparian plant communities present in the primary study area are located within the floodplain of the Sacramento River. These communities include Great Valley cottonwood riparian forest, Great Valley mixed riparian forest, and Great Valley valley oak riparian forest. Cottonwood- and willow-dominated riparian forest and woodland are present along active channels and on the lower flood terraces, whereas valley oak-dominated communities occur on higher flood terraces. In general, only narrow remnants of these riparian forests remain, often because levees are located close to river channels and the remaining riparian forest habitat is primarily confined to levee slopes. Riparian vegetation exists at Reading Island and some of the potential gravel augmentation sites.

Lower Sacramento River and Delta

Almost all of the forest land in the lower Sacramento River and Delta consists of riparian forests, including cottonwood-willow woodland and Valley oak riparian woodland. These areas are typically found in the lower Sacramento River and Delta as long, linear patches bordering waterways and agricultural or urban land. Riparian vegetation is most extensive on the water side of levees, but patches of riparian vegetation are also found on the interior of Delta islands along levee toes; along drainage channels; along pond margins; and in abandoned, low-lying fields. Forest land in riparian areas is managed primarily for habitat and water quality values, and to a lesser extent for recreation and other public benefits.

CVP/SWP Service Areas

Forest resources in the CVP/SWP service areas are similar to those discussed above for the upper Sacramento River and the lower Sacramento River and Delta. Agricultural and urban land uses have substantially reduced the area and connectivity of forest land in the CVP/SWP service areas. The region’s natural landscape changed substantially in the late 1800s and early 1900s as land uses were converted to agriculture. In Southern California, however, the land use pattern shifted more dramatically than in the Central Valley, as urban growth in the region that started in the 1900s began to convert large areas of forest land to developed land uses.

10.2 Regulatory Framework

10.2.1 Federal

Farmland Protection Policy Act

The Farmland Protection Policy Act is intended to minimize the effect of Federal programs with respect to the conversion of farmland to nonagricultural uses. It ensures that, to the extent possible, Federal programs are administered to be compatible with State, local, and private programs and policies to protect farmland. The U.S. Natural Resources Conservation Service (NRCS), part of the U.S. Department of Agriculture, is the agency primarily responsible for implementing the Farmland Protection Policy Act.

The Farmland Protection Policy Act established the Farmland Protection Program and the Land Evaluation and Site Assessment system. The Farmland Protection Program, a voluntary program administered by NRCS, provides funds to help purchase development rights to keep productive farmland in agricultural uses. The program provides matching funds to State, local, and tribal entities and nongovernmental organizations with existing farmland protection programs to purchase conservation easements. Participating landowners agree not to convert the land to nonagricultural uses and retain all rights to the property for future agriculture. A minimum 30-year term is required for conservation easements, and priority is given to applications with perpetual easements. NRCS provides up to 50 percent of the fair market value of the easement (NRCS 2006).

The Land Evaluation and Site Assessment system is a tool used to rank lands for suitability and inclusion in the Farmland Protection Program. The Land Evaluation and Site Assessment evaluates several factors: soil potential for agriculture, climate, location, market access, and adjacent land use. These factors are used to numerically rank land parcels based on local resource evaluation and site considerations (NRCS 2006).

10.2.2 State

California Important Farmland Inventory System and Farmland Mapping and Monitoring Program

DOC's Office of Land Conservation maintains a statewide inventory of farmlands, which are mapped by the DOC Division of Land Resource Protection as part of the FMMP. The FMMP was established by the State in 1982 to continue the Important Farmland mapping efforts begun in 1975 by the U.S. Soil Conservation Service (now called NRCS). The intent of the U.S. Soil Conservation Service was to produce agricultural-resource maps based on soil quality and land use across the nation. DOC sponsors the FMMP and is also responsible for establishing agricultural easements in accordance with PRC Sections 10250-10255. The maps are updated every 2 years with the use of aerial photographs, a computer mapping system, public review, and field reconnaissance.

As part of the nationwide effort to map agricultural land uses, the U.S. Soil Conservation Service/NRCS developed a series of definitions known as Land Inventory and Monitoring criteria. These criteria classify the land's suitability for agricultural production. Suitability includes both the physical and chemical characteristics of soils and the actual land use. Important Farmland maps are derived from NRCS soil survey maps using the Land Inventory and Monitoring criteria and are available by county. The maps prepared by NRCS classify land into one of eight categories, defined as follows (DOC 2011):

- **Prime Farmland –** Land that has the best combination of physical and chemical characteristics for crop production. This land has the soil quality, growing season, and moisture supply needed to produce sustained high yields of crops when treated and managed.

- **Farmland of Statewide Importance –** Land other than Prime Farmland that has a good combination of physical and chemical characteristics for crop production. This land has minor shortcomings, such as greater slopes or less ability to store soil moisture than Prime Farmland.

- **Unique Farmland –** Land that does not meet the criteria for Prime Farmland or Farmland of Statewide Importance, but that has been used for the production of specific crops with high economic value. This land is usually irrigated, but may include nonirrigated orchards or vineyards as found in some climatic zones in California.

- **Farmland of Local Importance –** Land that either is currently producing crops or has the capability of production, but does not meet the criteria of the categories above. Farmland of Local Importance is defined by each county's local advisory committee and adopted by its board of supervisors.

- **Grazing Land –** Land on which the vegetation is suited to the grazing of livestock. The minimum mapping unit for Grazing Land is 40 acres.

- **Urban and Built-up Lands –** Land occupied by structures with a density of at least one dwelling unit per 1.5 acres.

- **Land Committed to Nonagricultural Use –** Vacant areas; existing lands that have a permanent commitment to development but have an existing land use of agricultural or grazing lands.

- **Other Lands –** Land that does not meet the criteria of the remaining categories. This optional designation allows local governments to provide detail on the nature of changes expected to occur in the future.

Important Farmland is classified by DOC as Prime Farmland, Farmland of Statewide Importance, Unique Farmland, or Farmland of Local Importance. The total acreages of Urban and Built-up Lands and Other Lands are calculated by DOC and are defined by DOC as agricultural land.

The designations for Prime Farmland, Farmland of Statewide Importance, Unique Farmland, and Farmland of Local Importance are defined together under the terms "Agricultural Land" and "Important Farmland" in CEQA (PRC Sections 21060.1 and 21095) and Appendix G of the State CEQA Guidelines. The conversion of these types of farmland could be considered an environmental impact.

Williamson Act Contracts

The California Land Conservation Act of 1965, commonly known as the Williamson Act, is the principal method for encouraging the preservation of agricultural lands in California. The Williamson Act enables local governments to enter into contracts with private landowners for the purpose of restricting specific parcels of land to agricultural or related open-space use for 10 years. In return, landowners receive property tax assessments that are based on farming and open-space uses as opposed to full market value. Local governments receive an annual subvention (subsidy) of forgone property tax revenues from the State via the Open Space Subvention Act of 1971.

The Williamson Act empowers local governments to establish "agricultural preserves" consisting of lands devoted to agricultural uses and other uses that are compatible with agriculture. Upon establishing such a preserve, the locality may offer to the owner of included agricultural land the opportunity to enter into an annually renewable contract that restricts the land to agricultural use for at least 10 years. (The contract continues to run for 10 years after the first date upon which the contract is not renewed.) In return, the landowner is guaranteed a relatively stable tax base, founded on the value of the land for agricultural/open space use only and unaffected by its development potential.

Canceling a Williamson Act contract involves an extensive review and approval process, in addition to payment of fees of up to 12.5 percent of the property value. The local jurisdiction approving the cancellation must find that the cancellation is consistent with the purpose of the California Land Conservation Act or is in the public interest. Several subfindings must be made to support either finding, as defined in Section 51282 of the California Government Code.

Farmland Security Zones

Farmland Security Zones (FSZ), also known as Super Williamson Act lands, were established by DOC with the same general intent as Williamson Act contracts. Agricultural landowners in FSZs may enter into contracts with the county for 20-year increments, with an additional 35 percent tax benefit over and above the standard Williamson Act contract. The FSZ program has been adopted by 25 counties, although not all of those counties have executed contracts. FSZ contracts constitute nearly 2 percent of statewide Williamson Act enrollment.

An FSZ must be located in an agricultural preserve (area designated as eligible for a Williamson Act contract) and designated as Prime Farmland, Farmland of Statewide Importance, Unique Farmland, or Farmland of Local Importance. Land protected in an FSZ cannot be annexed by a city or county government or school district.

An FSZ contract can be terminated through a nonrenewal or cancellation. The nonrenewal allows a rollout process to occur over the remainder of the term of the contract, when the tax rates would gradually rise to the full rate by the end of the 20-year term. A cancellation must be applied for and approved by the DOC director and must meet specific criteria. The cancellation must be in the public interest and consistent with Williamson Act criteria. If a cancellation is approved, fees equal to 25 percent of the full market value of the property must be paid.

Agricultural Water Management Plans

By the end of 2004, 62 water districts, 3 environmental interest groups, and more than 53 other interested groups had signed the Agricultural Water Management Memorandum of Understanding as members of the Agricultural Water Management Council. The agricultural signatories represent more than 4.75 million acres of irrigated agricultural land statewide.

In 2004, the council endorsed an additional three agricultural water management plans that had been submitted by agricultural water suppliers to the council. These plans have since become the basis for the districts' water conservation efforts. The districts with endorsed agricultural water management plans are expected to prepare and submit a biannual progress report to the Agricultural Water Management Council, starting from the date their plan was endorsed. DWR staff members provide technical review and evaluation of these plans. DWR also reviewed two biannual progress reports for the council. DWR staff also provided technical assistance to water districts to prepare water management plans and helped implement efficient water management practices, as well as administrative and programmatic assistance to both the Agricultural Water Management Council and water districts.

1992 Delta Protection Act

The 1992 Delta Protection Act identified the Delta as a natural resource of statewide significance, formalized the State's commitment to preserve its diverse values, and established the Delta Protection Commission. The purpose of the Delta Protection Act is to ensure protection, maintenance, and enhancement of the Delta environment; ensure orderly and balanced use of Delta land resources; and improve flood protection to increase public health and safety. The Delta Protection Commission has planning jurisdiction over portions of five counties: Contra Costa, Sacramento, San Joaquin, Solano, and Yolo.

In Section 29703a of the Delta Protection Act, the Delta Primary Zone is designated as an area for protection from intrusion of nonagricultural uses. In 1995, the Delta Protection Commission adopted its regional plan, *Land Use and Resource Management Plan for the Primary Zone of the Delta* (also known as the Delta Plan). The current Delta Plan was approved by the California Office of Administrative Law on October 7, 2010, and became effective November 6, 2010. Policies in the Delta Plan are developed to project the conversion of agricultural resources. Policy P-2 states that conversion of land to non-agriculturally oriented uses should occur first where productivity and agricultural values are lowest. Policy P-6 encourages acquiring agricultural conservation easements from willing sellers as mitigation for projects within each county. Use of environmental mitigation is to be promoted in agricultural areas only when it is consistent and compatible with ongoing agricultural operations and when developed in appropriate locations designated on a countywide or Deltawide habitat management plan (DPC 2010).

10.2.3 Regional and Local

Shasta and Tehama Counties

The general plans of Shasta and Tehama counties contain goals, policies, and implementation measures to protect agricultural lands, as summarized below.

Shasta County General Plan The *Shasta County General Plan* (Shasta County 2004) identifies goals, policies, and implementation measures aimed at conserving large contiguous areas of productive agricultural land, providing opportunities for the future expansion of such uses, and protecting them from development pressures that would adversely affect or hinder existing or future agricultural operations. This includes the objective to protect water resources and supply systems vital for the continuation of agriculture.

Tehama County General Plan The *Tehama County General Plan* (2009) encourages and supports agriculture and forest resources in Tehama County. The policies are within the Agriculture and Timber Element of the general plan and divided into the Land Use, Open Space and Conservation, and Economic Development elements to aid in implementation of the general plan, but focus on agriculture nonetheless.

Other

Sacramento River Conservation Area The Sacramento River Conservation Area seeks to promote the reestablishment of the 100-year floodplain along the Sacramento River. In 1986, the California Legislature passed Senate Bill 1086, which called for a management plan for the Sacramento River that would help restore, protect, and enhance the riparian and aquatic habitat. After much debate, the *Upper Sacramento River Fisheries and Riparian Habitat Management Plan* was developed (Resources Agency 1989). This plan called for fish bypass structures on the Sacramento River and its tributaries, as well as the Shasta Dam temperature control structure. After implementation of these projects began, the advisory council reconvened to complete additional work. This effort led to the *Sacramento River Conservation Area Handbook* (Resources Agency 2003), which would guide riparian habitat management along the river. In 1999, a memorandum of agreement was signed by most entities involved in management activities along the river. The U.S. Bureau of Land Management has acquired roughly 15,000 acres of riparian lands along the Sacramento River.

10.3 Environmental Consequences and Mitigation Measures

10.3.1 Methods and Assumptions

Implementation of the project would result in construction-related, maintenance-related, and operational impacts that could substantially affect agricultural and forest resources. This analysis evaluates potential construction-related and operational activities that could directly or indirectly affect existing agricultural and forest resources in the primary study area. Indirect impacts on the extended study area could result from alteration of flow regimes downstream from Shasta Lake and downstream from other reservoirs with altered operations, as well as increased inundation width of the Sacramento River during the growing season. In addition, water supply reliability in the CVP/SWP service areas could increase, which in turn could reduce limitations on growth and increase development that could adversely affect agricultural and forest resources.

Evaluation of the project's potential impacts on agricultural resources was based on a review of the planning documents pertaining to the study area, including goals and policies from the general plans of Shasta and Tehama counties. DOC's Important Farmland and Williamson Act maps were used to determine the agricultural significance of the lands in the primary study area. In addition, the results of CalSim-II simulations were reviewed to assess changes in flow regime in the primary and extended study areas.

Forest land that could be inundated or otherwise affected by implementation of any of the action alternatives was determined from vegetation mapping as described in Chapter 12, "Botanical Resources and Wetlands." These forest lands consist of blue oak-foothill pine, blue oak, and closed-cone pine-cypress woodlands; and Douglas-fir, montane hardwood, montane hardwood-conifer, montane riparian, Ponderosa pine, and valley-foothill riparian forests. The following analysis summarizes information provided in Chapter 12, "Botanical Resources and Wetlands," as it relates to the potential conversion of forest land to nonforest uses.

10.3.2 Criteria for Determining Significance of Effects

An environmental document prepared to comply with NEPA must consider the context and intensity of the environmental effects that would be caused by, or result from, the proposed action. Under NEPA, the significance of an effect is used solely to determine whether an EIS must be prepared. An environmental document prepared to comply with CEQA must identify the potentially significant environmental effects of a proposed project. A "[s]ignificant effect on the environment" means a substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by the project" (State CEQA Guidelines, Section 15382). CEQA also requires that the environmental document propose feasible measures to avoid or substantially reduce significant environmental effects (State CEQA Guidelines, Section 15126.4(a)).

The following significance criteria were developed based on guidance provided by the State CEQA Guidelines, and consider the context and intensity of the environmental effects as required under NEPA. Impacts of an alternative on agriculture and Important Farmland would be significant if project implementation would do any of the following:

- Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance, as shown on the maps prepared pursuant to the FMMP of the Resources Agency, to nonagricultural use
- Conflict with existing zoning for agricultural use, or a Williamson Act contract
- Conflict with existing zoning for, or cause rezoning of, forest land (as defined in PRC Section 12220(g)), timberland (as defined in PRC Section 4526), or timberland zoned Timberland Production (as defined in PRC Section 51104(g))
- Result in the loss of forest land or conversion of forest land to nonforest use
- Involve other changes in the existing environment that, because of their location or nature, could result in conversion of farmland, to nonagricultural use or the conversion of forest land to nonforest use

10.3.3 Topics Eliminated from Further Consideration

None of the lands in the primary study area are zoned as forest land, timberland, or timberland zoned Timberland Production by the *Shasta County General Plan* (2004) or *Tehama County General Plan* (2009). Increasing water supply reliability within the lower Sacramento River to the Delta and within the CVP/SWP service areas would not conflict with existing zoning or directly result in the rezoning of forest land, timberland, or timberland zoned Timberland Production. Therefore, no effects related to conflicts with existing zoning or causing rezoning of forest land are expected to occur in the study area. Potential effects related to this issue area are not discussed further in this EIS.

10.3.4 Direct and Indirect Effects

No-Action Alternative

Under the No-Action Alternative, the existing Shasta Dam would be operated in the same manner as under current operations. Shasta Dam would not be enlarged and no infrastructure would be removed, modified, or relocated. Changes to the reservoir flow regime caused by changes in demand and other factors would be small, with a reduction in Shasta Lake storage of 2–4 percent during the fall of some years. Shasta Lake storage under the No-Action Alternative would be within -2 percent and 1 percent of existing Shasta Lake storage at most times.

Changes to the flow regime of the upper Sacramento River caused by changes in demand and other factors would be small under the No-Action Alternative; mean monthly flows in the Sacramento River would be within 5 percent of existing flows at most times. (Flows could increase by a greater amount during late summer and early fall of below-normal, dry, and critical years.)

In addition, Shasta Lake operations under the No-Action Alternative would not change the flow regime in the lower Sacramento River and Delta. If none of the project alternatives were implemented, CVP and SWP operations would likely continue under existing regulatory requirements. CVP and SWP water storage, conveyance, and deliveries would change because of several reasonably foreseeable actions that would occur with or without enlargement of Shasta Dam. Overall, CalSim-II modeling results suggest that only a very small decrease in flows greater than 15,000 cubic feet per second would occur.

Shasta Lake and Vicinity

Impact Ag-1 (No-Action): Direct and Indirect Conversion of Important Farmland to Nonagricultural Uses and Cancellation of Williamson Act Contracts in the Vicinity of Shasta Lake No new facilities would be constructed at Shasta Lake and no operational changes would occur that would directly convert Important Farmland to nonagricultural uses or result in the cancellation of Williamson Act contracts in the vicinity of Shasta Lake. However, California's demand for water for irrigation and other uses is expected to continue to increase while the water supply will likely become less reliable. This trend could lead to increased pressure to convert Important Farmland to other nonagricultural uses and cancel Williamson Act contracts, resulting in an indirect impact. Therefore, this impact would be potentially significant.

Under the No-Action Alternative, Shasta Dam would not be enlarged; no infrastructure would be removed, modified, or relocated; and Reclamation's

Shasta operations would not change. Changes to the reservoir flow regime and reservoir storage caused by changes in demand and other factors would be small, and generally the same as under existing conditions at most times. Therefore, implementing the No-Action Alternative would not directly convert agricultural land to nonagricultural uses or result in the cancellation of Williamson Act contracts.

The demand for water for irrigation and other uses in California is expected to continue to increase in the future. At the same time, the water supply may become less reliable because of increasing environmental water requirements for special-status species, decreasing water quality, and climate change. Therefore, the No-Action Alternative could have an indirect, adverse impact on agricultural land uses and Important Farmland in the primary study area. Insufficient water supply, especially during drought periods, could indirectly lead to increased pressure on farmers to convert Important Farmland to other nonagricultural uses, or could cause land designated as Important Farmland to be fallowed. Additionally, the conversion of Important Farmland could involve cancellation or expiration of many Williamson Act contracts.

The magnitude and extent of the agricultural land that could be converted from changes in water supply is unknown; however, any loss of Important Farmland would be significant because there are no measures to fully mitigate the loss of Important Farmland. Based on a review of future demand projections used in CalSim-II modeling and estimated deliveries under the No-Action Alternative, this impact would be potentially significant. Mitigation is not required for the No-Action Alternative.

Impact Ag-2 (No-Action): Direct and Indirect Conversion of Forest Land to Nonforest Uses in the Vicinity of Shasta Lake No new facilities would be constructed at Shasta Lake and no operational changes would occur that would result in the direct or indirect conversion of forest land to nonforest uses. No impact would occur.

Under the No-Action Alternative, Shasta Dam would not be enlarged; no infrastructure would be removed, modified, or relocated; and Reclamation's Shasta operations would not change. Changes to the reservoir flow regime and reservoir storage caused by changes in demand and other factors would be small and generally the same as under existing conditions at most times. Therefore, the No-Action Alternative would not result in the direct or indirect conversion to nonforest uses of blue oak-foothill pine, blue oak, and closed-cone pine-cypress woodlands; Douglas-fir, montane hardwood, montane hardwood-conifer, montane riparian, Ponderosa pine, and valley-foothill riparian forests; or other forest land. No impact would occur. Mitigation is not required for the No-Action Alternative.

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact Ag-3 (No-Action): Direct and Indirect Conversion of Important Farmland to Nonagricultural Uses and Cancellation of Williamson Act Contracts Along the Upper Sacramento River Changes to the flow regime of the upper Sacramento River caused by changes in demand and other factors would be small under the No-Action Alternative; mean monthly flows in the Sacramento River would be within 5 percent of flows under existing conditions at most times. Implementing the No-Action Alternative would not directly convert Important Farmland to nonagricultural uses or result in the cancellation of Williamson Act contracts in the upper Sacramento River portion of the primary study area. However, California's demand for water for irrigation and other uses is expected to continue to increase while the water supply will likely become less reliable. This trend could lead to increased pressure to convert Important Farmland to other nonagricultural uses and cancel Williamson Act contracts, resulting in an indirect impact. Therefore, this impact would be potentially significant.

Changes to the flow regime of the upper Sacramento River resulting from changes in demand and other factors would be small under the No-Action Alternative; mean monthly flows in the Sacramento River would be within 5 percent of flows under existing conditions at most times. Therefore, implementing the No-Action Alternative would not directly convert agricultural land to nonagricultural uses or result in the cancellation of Williamson Act contacts.

California's demand for water for irrigation and other uses is expected to continue to increase in the future. At the same time, the water supply may become less reliable because of increasing environmental water requirements for special-status species, population growth that places further demands on existing water supply resources, decreasing water quality, and climate change. Therefore, the No-Action Alternative could have an indirect adverse impact on agricultural land uses and Important Farmland in the primary study area. Insufficient water supply, especially during drought periods, could indirectly lead to increased pressure on farmers to convert Important Farmland to other nonagricultural uses or cause land designated as Important Farmland to be fallowed. Additionally, conversion of Important Farmland could involve canceling many Williamson Act contracts or allowing such contracts to expire.

The magnitude and extent of the agricultural land that could be converted from changes in water supply is unknown; however, any loss of Important Farmland would be significant because there are no measures to fully mitigate the loss of Important Farmland. Based on a review of future demand projections used in CalSim-II modeling and estimated deliveries under the No-Action Alternative, this impact would be potentially significant. Mitigation is not required for the No-Action Alternative.

Impact Ag-4 (No-Action): Direct and Indirect Conversion of Forest Land to Nonforest Uses Along the Upper Sacramento River No operational changes would occur that would directly convert forest land to nonforest uses along the upper Sacramento River. However, water storage, conveyance, and deliveries would change because of several reasonably foreseeable actions that would occur with or without enlargement of Shasta Dam. The resulting changes in the flow regime would likely result in minimal adverse effects on riparian forest and oak woodland habitats. Furthermore, management and restoration plans and programs would implement actions that would largely offset those adverse effects. Therefore, this impact would be less than significant.

Under the No-Action Alternative, no changes in Reclamation's Shasta operations would occur that would directly convert riparian and oak woodland habitats along the upper Sacramento River to nonforest uses. However, water storage, conveyance, and deliveries would change because of several reasonably foreseeable actions that would occur with or without enlargement of Shasta Dam. As a consequence of these actions, the flow regime of the upper Sacramento River would change between 2005 and 2030. As described in Chapter 12, "Botanical Resources and Wetlands," this change in flow regime would likely result in minimal adverse effects on forest land, which along the upper Sacramento River consist of riparian forest and oak woodlands, and these effects would not be sufficient to alter the extent of these forest lands.

As also discussed in Chapter 12, several management and restoration plans and programs would be implemented under the No-Action Alternative. These actions would cause beneficial effects likely to be of a magnitude similar to or greater than the anticipated adverse effects of small changes in flow regime; thus, implementation of the plans and programs would largely offset those adverse effects. Therefore, this impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Lower Sacramento River and Delta and CVP/SWP Service Areas

Impact Ag-5 (No-Action): Direct and Indirect Conversion of Important Farmland to Nonagricultural Uses and Cancellation of Williamson Act Contracts in the Extended Study Area Changes to the flow regime of the lower Sacramento River, Delta, and CVP/SWP service areas caused by changes in demand and other factors would be small under the No-Action Alternative; mean monthly flows in the Sacramento River would be within 5 percent of flows under existing conditions at most times. Implementing the No-Action Alternative would not directly convert Important Farmland to nonagricultural uses or result in the cancellation of Williamson Act contracts along the lower Sacramento River, in the Delta, or in the CVP/SWP service areas. However, California's demand for water for irrigation and other uses is expected to continue to increase while the water supply will likely become less reliable. This trend could lead to increased pressure to convert Important Farmland to other nonagricultural uses and cancel Williamson Act contracts, resulting in an indirect impact. Therefore, this impact could be potentially significant.

This impact would be similar to Impact Ag-3 (No-Action) for the upper Sacramento River (Shasta Dam to Red Bluff). For the same reasons as described above for Impact Ag-3 (No-Action), this impact would be potentially significant. Mitigation is not required for the No-Action Alternative.

Impact Ag-6 (No-Action): Direct and Indirect Conversion of Forest Land to Nonforest Uses in the Extended Study Area No operational changes would occur under the No-Action Alternative that would directly convert forest land to nonforest uses in the extended study area. However, water storage, conveyance, and deliveries would change because of several reasonably foreseeable actions that would occur with or without enlargement of Shasta Dam. The resulting changes in the flow regime would likely result in minimal adverse effects on forest land, which consists of riparian forest and oak woodlands along the lower Sacramento River and in the Delta. Management and restoration plans and programs would implement actions that would largely offset those adverse effects. Therefore, this impact would be less than significant.

This impact would be similar to Impact Ag-4 (No-Action) for the upper Sacramento River (Shasta Dam to Red Bluff). For the same reasons as described above for Impact Ag-4 (No-Action), this impact would be less than significant. Mitigation is not required for the No-Action Alternative.

CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

By increasing storage at Shasta Lake, this alternative would change the full pool elevation and seasonal pool elevations at Shasta Lake, and the flow regime downstream in the Sacramento River and potentially several other reservoirs and downstream waterways. By raising Shasta Dam 6.5 feet, CP1 would increase the height of the reservoir's full pool elevation by 8.5 feet, enlarge the total storage capacity in the reservoir by 256,000 acre-feet, and increase the reservoir's surface area at full pool by about 1,110 acres (4 percent). Areas at this elevation could be periodically inundated; existing facilities within the inundation zone would be relocated to higher areas to accommodate the periodic inundation. In general, the effect of this increase would be slight, given that the reservoir would exceed the current full pool elevation only during wetter-than-normal years.

Shasta Dam's operational guidelines would continue essentially unchanged, except during dry and critical years, when 70,000 acre-feet and 35,000 acre-feet, respectively, of the increased storage capacity in Shasta Reservoir would be reserved to specifically focus on increasing M&I deliveries. Implementing CP1 would help reduce estimated future agricultural water shortages in the CVP/SWP service areas by increasing water supplies for agricultural deliveries by at least 22,500 acre-feet per year in dry and critical years and increasing average annual deliveries by about 20,300 acre-feet per year.

Potential impacts of CP1 on the upper Sacramento River's flow and stages and on deliveries of water supplies to the CVP/SWP service areas would be small. On average, in each month, changes in mean monthly flow relative to existing (2005) and No-Action Alternative (2030) conditions would be reductions or increases of about 5 percent or less. Generally, the relative magnitude of effects on river flows diminishes with distance downstream because of the influence of inflows from tributaries and the effects of diversions and flood bypasses.

Shasta Lake and Vicinity

Impact Ag-1 (CP1): Direct and Indirect Conversion of Important Farmland to Nonagricultural Uses and Cancellation of Williamson Act Contracts in the Vicinity of Shasta Lake No lands adjacent to Shasta Lake or in the immediate vicinity above Shasta Dam are designated by DOC as Important Farmland or under Williamson Act contracts. No impact would occur.

No lands adjacent to Shasta Lake or in the immediate vicinity above Shasta Dam are designated by DOC as Important Farmland or under Williamson Act contracts. Therefore, inundation of land and removal, modification, or relocation of infrastructure under CP1 would not directly or indirectly convert agricultural land to nonagricultural uses or result in the cancellation of Williamson Act contacts. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact Ag-2 (CP1): Direct and Indirect Conversion of Forest Land to Nonforest Uses in the Vicinity of Shasta Lake Inundation of land and removal, modification, or relocation of infrastructure under CP1 would result in the conversion of forest land to nonforest uses. This impact would be significant.

A total of 1,032 acres of forest land would be affected by inundation under CP1 (Table 10-5). Also, up to 844 acres of land in the relocation areas would be affected by removal, modification, relocation, or inundation of roadways, bridges, utilities, and campgrounds under CP1 (Table 10-6); most of this acreage would be converted from forest land to nonforest uses. This impact would be significant. Mitigation for this impact is not proposed in Section 10.3.5 because no feasible mitigation is available to reduce the impact to a less-than-significant level.

Table 10-5. Acreage of Forest Land that Would Be Affected by Inundation Under CP1

Forest Land	Area (Acres)
Blue oak–foothill pine	10
Blue oak woodland	1
Closed-cone pine–cypress	247
Douglas-fir	<1
Montane hardwood	190
Montane hardwood–conifer	239
Ponderosa pine	345
Total	**1,032**

Key:
< = less than
CP = Comprehensive Plan

Table 10-6. Maximum Acreage of Forest Land that Would Be Affected in Relocation Areas Under CP1–CP5

Forest Land	Area (Acres)
Blue oak–foothill pine	22
Blue oak woodland	5
Closed-cone pine–cypress	90
Douglas-fir	3
Montane hardwood	715
Montane hardwood–conifer	9
Ponderosa pine	<1
Total	**844**

Key:
< = less than
CP = Comprehensive Plan

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact Ag-3 (CP1): Direct and Indirect Conversion of Important Farmland to Nonagricultural Uses and Cancellation of Williamson Act Contracts Along the Upper Sacramento River Agricultural lands in the upper Sacramento River portion of the primary study area, including Important Farmland and Williamson Act contract lands, could be inundated as a result of increases in mean monthly river flows. The flow increases that would occur in some years would generally be small (5 percent or less) and would affect areas periodically inundated under existing conditions or the No-Action Alternative. The effects of increased flows would diminish with distance downstream as tributary inflows, and the effects of diversions and flood bypasses, affect flows in the Sacramento River. CP1 also would increase the reliability of the water supply by increasing water supplies for irrigation purposes, primarily during dry and critical years.

Therefore, implementing CP1 would not directly or indirectly result in the conversion of Important Farmland to nonagricultural uses or the cancellation of Williamson Act contracts. This impact would be less than significant.

Agricultural lands in the upper Sacramento River portion of the primary study area, including Important Farmland and Williamson Act contract lands, could be inundated or could undergo soil saturation as a result of project-related increases in mean monthly river flows. Based on CalSim-II model simulations, the flow increases that would occur in some years under CP1 would likely be small (5 percent or less) relative to existing (2005) and No-Action Alternative (2030) conditions. These increased flows would affect small areas periodically inundated under existing conditions or the No-Action Alternative. In addition, the effects would diminish with distance downstream because of the influence of inflows from tributaries and the effects of diversions and flood bypasses. As a result, implementing CP1 would not directly result in the conversion of Important Farmland to nonagricultural uses or the cancellation of Williamson Act contracts.

Implementing CP1 would increase the reliability of the water supply by increasing water supplies in the upper Sacramento River portion of the primary study area for irrigation purposes, primarily during dry and critical years. A substantial portion of this water would be used instead of groundwater, would allow for changes in agricultural irrigation practices, or would enable farmers to return idle cropland to production. Therefore, implementing CP1 would not indirectly result in the conversion of Important Farmland to nonagricultural uses or the cancellation of Williamson Act contracts.

For the reasons described above, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Ag-4 (CP1): Direct and Indirect Conversion of Forest Land to Nonforest Uses Along the Upper Sacramento River   Altered flow regimes associated with project implementation under CP1 could adversely affect forest land along the upper Sacramento River. The altered flow regime could affect oak woodland communities by prolonging inundation and changing the availability of soil moisture; however, these effects are unclear and may not all prove to be adverse. Changes in the magnitude of intermediate and large flows would likely be sufficient to alter the dynamics and structure of forests in the riparian corridor along the upper Sacramento River in the future. However, changes in the flow regime would not reduce the extent of riparian forest. Therefore, implementing CP1 would not result in the conversion of forest land to nonforest uses. This impact would be less than significant.

Forest land along the upper Sacramento River consists of riparian forest and oak woodlands. These habitats could be affected by changes in river flow and stage in some years. In most years, changes in mean monthly flow would be reductions or increases of 5 percent or less. The areas affected would be areas periodically inundated under existing conditions and the No-Action Alternative. Generally, these effects diminish with distance downstream because of the influence of inflows from tributaries, and the effects of diversions and flood bypasses.

The altered flow regime of the upper Sacramento River associated with implementation of CP1 could affect oak woodland communities by prolonging inundation and changing the availability of soil moisture. This effect would occur during years when mean monthly stage during March–October would differ from existing and No-Action Alternative conditions. Implementing CP1 could slightly increase the average elevation of the water surface in this zone (but would not increase the zone’s elevation range). Because of the important influence of water availability and soil aeration on plant growth and survival, these changes have the potential to result in the loss of oak woodlands. These effects are unclear, however, and may not all prove to be adverse.

The flow regime of a river or stream strongly influences the structure and species composition of riparian forests. Implementing CP1 would not alter the general annual pattern of flows but would reduce the magnitude, duration, and frequency of intermediate and large flows. Reductions in the magnitude of intermediate and large flows would likely be sufficient to alter the dynamics and structure of forests in the riparian corridor along the upper Sacramento River; however, changes in the flow regime would not reduce the extent of riparian forest.

For the reasons described above, implementing CP1 would not result in the conversion of forest land to nonforest uses. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta and CVP/SWP Service Areas
Impact Ag-5 (CP1): Direct and Indirect Conversion of Important Farmland to Nonagricultural Uses and Cancellation of Williamson Act Contracts in the Extended Study Area Agricultural lands in the extended study area, including Important Farmland and Williamson Act contract lands, could be inundated or undergo soil saturation as a result of increased mean monthly river flows. Increases in Sacramento River stage (elevation) would be small. These increased flows would affect areas periodically inundated or saturated under existing conditions or the No-Action Alternative. The effects of this inundation would diminish with distance downstream. CP1 also would increase the reliability of the water supply by increasing water supplies for irrigation purposes, primarily during dry and critical years. Therefore, implementing CP1 would not directly or indirectly result in the conversion of Important Farmland to nonagricultural uses or the cancellation of Williamson Act contracts. This impact would be less than significant.

Agricultural lands in the extended study area, including Important Farmland and Williamson Act contract lands, could experience more extensive inundation or soil saturation during some months as a result of project-related increases in mean monthly river flows. However, these increased flows would affect areas periodically inundated or saturated under existing conditions and/or the No-Action Alternative. In addition, the effects of inundation would diminish with distance downstream because of the influence of inflows from tributaries and the effects of diversions and flood bypasses. As a result, the direct conversion of agricultural land to nonagricultural uses or cancellation of Williamson Act contacts is unlikely to be substantial.

During dry and critical years, 70,000 acre-feet and 35,000 acre-feet, respectively, of the increased storage capacity in Shasta Reservoir would be reserved to specifically focus on increasing M&I deliveries. Implementing CP1 would help reduce estimated future agricultural water shortages in the CVP/SWP service areas by increasing water supplies for agricultural deliveries by at least 22,500 acre-feet per year in dry and critical years and increasing average annual deliveries by about 20,300 acre-feet per year. The majority of increased dry and critical year water supplies would be for south-of-Delta agricultural deliveries. A substantial portion of this water would be used instead of groundwater, would allow for changes in agricultural irrigation practices, or would enable farmers to return idle cropland to production. Therefore, implementing CP1 would not indirectly result in the conversion of Important Farmland to nonagricultural uses or the cancellation of Williamson Act contracts.

For the reasons described above, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Ag-6 (CP1): Direct and Indirect Conversion of Forest Land to Nonforest Uses in the Extended Study Area Altered flow regimes associated with project implementation under CP1 could adversely affect riparian forest and oak woodlands. The altered flow regime could affect oak woodlands by prolonging inundation and changing soil moisture in some years; however, these effects are unclear and may not all prove to be adverse. Changes in the magnitude of intermediate and large flows would likely be sufficient to alter the dynamics and structure of the riparian forests along the upper Sacramento River in the future. However, changes in flow regime would not reduce the extent of riparian forest. Therefore, implementing CP1 would not result in the conversion of forest land to nonforest uses. This impact would be less than significant.

This impact would be similar to Impact Ag-4 (CP1) for the upper Sacramento River. For the same reasons as described above for Impact Ag-4 (CP1), this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

Like CP1, CP2 would increase storage at Shasta Lake, thus changing the reservoir's full pool elevation and seasonal pool elevations, and the flow regime in the Sacramento River and potentially several other reservoirs and downstream waterways.

By raising Shasta Dam 12.5 feet, CP2 would increase the reservoir's full pool elevation by 14.5 feet and enlarge its total storage capacity by 443,000 acre-feet. Raising the dam 12.5 feet would increase the reservoir's surface area at full pool by about 1,900 acres (6 percent). In general, the effect of this increase would be slight, given that the reservoir would exceed the current full pool elevation only during wetter-than-normal years.

Shasta Dam's operational guidelines would continue essentially unchanged, except during dry and critical years, when 120,000 acre-feet and 60,000 acre-feet, respectively, of the increased storage capacity in Shasta Reservoir would be reserved to specifically focus on increasing M&I deliveries. Implementing CP2 would help reduce estimated future agricultural water shortages in the CVP/SWP service areas by increasing water supplies for agricultural deliveries by at least 37,600 acre-feet per year in dry and critical years and increasing average annual deliveries by about 31,400 acre-feet per year.

In general, the proposed changes in flow and river stage on the upper Sacramento River associated with CP2 would be similar to but slightly greater than the changes associated with CP1, as outlined above.

Shasta Lake and Vicinity

Impact Ag-1 (CP2): Direct and Indirect Conversion of Important Farmland to Nonagricultural Uses and Cancellation of Williamson Act Contracts in the Vicinity of Shasta Lake No lands adjacent to Shasta Lake or in the immediate vicinity above Shasta Dam are designated by DOC as Important Farmland or under Williamson Act contracts. No impact would occur.

This impact would be the same as Impact Ag-1 (CP1). No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact Ag-2 (CP2): Direct and Indirect Conversion of Forest Land to Nonforest Uses in the Vicinity of Shasta Lake Inundation of land and removal, modification, or relocation of infrastructure under CP2 would result in the conversion of forest land to nonforest uses. This impact would be significant.

A total of 1,440 acres of forest land would be affected by inundation under CP2 (Table 10-7). Also, up to 844 acres of land in the relocation areas would be affected by removal, modification, relocation, or inundation of roadways, bridges, utilities, and campgrounds under CP2 (Table 10-6); most of this acreage would be converted from forest land to nonforest uses. This impact would be significant. Mitigation for this impact is not proposed in Section 10.3.5 because no feasible mitigation is available to reduce the impact to a less-than-significant level.

Table 10-7. Acreage of Forest Land that Would Be Affected by Inundation Under CP2

Forest Land	Area (Acres)
Blue oak–foothill pine	15
Blue oak woodland	2
Closed-cone pine–cypress	343
Douglas-fir	<1
Montane hardwood	263
Montane hardwood–conifer	329
Ponderosa pine	488
Total	**1,440**

Key:
< = less than
CP = Comprehensive Plan

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact Ag-3 (CP2): Direct and Indirect Conversion of Important Farmland to Nonagricultural Uses and Cancellation of Williamson Act Contracts Along the Upper Sacramento River Agricultural lands in the upper Sacramento River portion of the primary study area, including Important Farmland and Williamson Act contract lands, could be inundated as a result of increases in mean monthly river flows. The flow increases that would occur in some years would generally be small and would affect areas periodically inundated under existing conditions or the No-Action Alternative. The effects of increased flows would diminish with distance downstream. CP2 also would increase the reliability of the water supply by increasing water supplies for irrigation purposes, primarily during dry and critical years. Therefore, implementing CP2 would not directly or indirectly result in the conversion of Important Farmland to nonagricultural uses or the cancellation of Williamson Act contracts. This impact would be less than significant.

This impact would be similar to but slightly greater than Impact Ag-3 (CP1), because alteration of the flow regime of the Sacramento River would be slightly greater under CP2 than under CP1. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Ag-4 (CP2): Direct and Indirect Conversion of Forest Land to Nonforest Uses Along the Upper Sacramento River Altered flow regimes associated with project implementation under CP2 could adversely affect forest land along the upper Sacramento River. The altered flow regime could affect oak woodland communities by prolonging inundation and changing the availability of soil moisture; however, these effects are unclear and may not all prove to be adverse. Changes in the magnitude of intermediate and large flows would likely be sufficient to alter the dynamics and structure of forests in the riparian corridor along the upper Sacramento River in the future. However, changes in the flow regime would not reduce the extent of riparian forest. Therefore, implementing CP2 would not result in the conversion of forest land to nonforest uses. This impact would be less than significant.

This impact would be similar to but slightly greater than Impact Ag-4 (CP1), because alteration of the flow regime of the Sacramento River would be slightly greater under CP2 than under CP1. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta and CVP/SWP Service Areas

Impact Ag-5 (CP2): Direct and Indirect Conversion of Important Farmland to Nonagricultural Uses and Cancellation of Williamson Act Contracts in the Extended Study Area Agricultural lands in the extended study area, including Important Farmland and Williamson Act contract lands, could be inundated or undergo soil saturation as a result of increased mean monthly river flows. Increases in Sacramento River stage (elevation) would be small. These increased flows would affect areas periodically inundated or saturated under existing conditions or the No-Action Alternative. The effects of this inundation would diminish with distance downstream. CP2 also would increase the reliability of the water supply by increasing water supplies for irrigation purposes, primarily during dry and critical years. Therefore, implementing CP2 would not directly or indirectly result in the conversion of Important Farmland to nonagricultural uses or the cancellation of Williamson Act contracts. This impact would be less than significant.

This impact would be similar to but slightly greater than Impact Ag-5 (CP1), because alteration of the flow regime of the Sacramento River would be slightly greater under CP2 than under CP1. In addition, CP2 would include reserving more storage capacity in Shasta Reservoir to specifically focus on increasing M&I deliveries during dry and critical years and a greater volume of dry and critical year and average annual water supply for agricultural water deliveries for the CVP/SWP service areas. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Ag-6 (CP2): Direct and Indirect Conversion of Forest Land to Nonforest Uses in the Extended Study Area Altered flow regimes associated with project implementation under CP2 could adversely affect riparian forest and oak woodlands. The altered flow regime could affect oak woodlands by prolonging inundation and changing soil moisture in some years; however, these effects are unclear and may not all prove to be adverse. Changes in the magnitude of intermediate and large flows would likely be sufficient to alter the dynamics and structure of the riparian forests along the upper Sacramento River in the future. However, changes in flow regime would not reduce the extent of riparian forest. Therefore, implementing CP2 would not result in the conversion of forest land to nonforest uses. This impact would be less than significant.

This impact would be similar to but slightly greater than Impact Ag-6 (CP1), because alteration of the flow regime of the Sacramento River would be slightly greater under CP2 than under CP1. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CP3 – 18.5-Foot Dam Raise, Agricultural Water Supply Reliability and Anadromous Fish Survival

Like both of the alternatives discussed above, CP3 would increase storage at Shasta Lake, thus changing the reservoir's full pool elevation and seasonal pool elevations and the flow regime in the Sacramento River and potentially several other reservoirs and downstream waterways.

By raising Shasta Dam 18.5 feet, CP3 would increase the reservoir's full pool elevation by 20.5 feet and enlarge its total storage capacity by 634,000 acre-feet. Raising the dam 18.5 feet would increase the reservoir's surface area at full pool by about 2,570 acres (9 percent). In general, the effect of this increase would be slight, given that the reservoir would exceed the current full pool elevation only during wetter-than-normal years.

Implementing CP3 would increase water supply reliability by increasing dry and critical year water supplies for CVP irrigation deliveries. None of the increased storage capacity in Shasta Reservoir would be reserved for increasing M&I deliveries. However, CP3 would help reduce estimated future water shortages for CVP agricultural water users by increasing the reliability of water supplies for agricultural deliveries by at least 70,600 acre-feet per year in dry and critical years and increasing average annual deliveries by about 62,200 acre-feet per year.

In general, the changes in flow and river stage on the upper Sacramento River associated with CP3 would be more substantial than the changes associated with CP1 and CP2. However, these anticipated changes would still be within a few percentage points of the changes associated with CP1 and CP2, as outlined above.

Shasta Lake and Vicinity

Impact Ag-1 (CP3): Direct and Indirect Conversion of Important Farmland to Nonagricultural Uses and Cancellation of Williamson Act Contracts in the Vicinity of Shasta Lake No lands adjacent to Shasta Lake or in the immediate vicinity above Shasta Dam are designated by DOC as Important Farmland or under Williamson Act contracts. No impact would occur.

This impact would be the same as Impact Ag-1 (CP1). No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact Ag-2 (CP3): Direct and Indirect Conversion of Forest Land to Nonforest Uses in the Vicinity of Shasta Lake Inundation of land and removal, modification, or relocation of infrastructure under CP3 would result in the conversion of forest land to nonforest uses. This impact would be significant.

A total of 2,069 acres of forest land would be affected by inundation under CP3 (Table 10-8). Also, up to 844 acres of land in the relocation areas would be affected by removal, modification, or relocation of infrastructure under CP3 (Table 10-6); most of this acreage would be converted from forest land to nonforest uses. This impact would be significant. Mitigation for this impact is not proposed in Section 10.3.5 because no feasible mitigation is available to reduce the impact to a less-than-significant level.

Table 10-8. Acreage of Forest Land that Would Be Affected by Inundation Under CP3

Forest Land	Area (Acres)
Blue oak–foothill pine	17
Blue oak woodland	7
Closed-cone pine–cypress	485
Douglas-fir	<1
Montane hardwood	376
Montane hardwood–conifer	481
Ponderosa pine	703
Total	**2,069**

Key:
< = less than
CP = Comprehensive Plan

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact Ag-3 (CP3): Direct and Indirect Conversion of Important Farmland to Nonagricultural Uses and Cancellation of Williamson Act Contracts Along the Upper Sacramento River Agricultural lands in the upper Sacramento River portion of the primary study area, including Important Farmland and Williamson Act contract lands, could be inundated as a result of increases in mean monthly river flows. The flow increases that would occur in some years would generally be small (5 percent or less) and would affect areas periodically inundated under existing conditions or the No-Action Alternative. The effects of increased flows would diminish with distance downstream. CP3 also would increase the reliability of the water supply by increasing water supplies for irrigation purposes, primarily during dry and critical years. Therefore, implementing CP3 would not directly or indirectly result in the conversion of Important Farmland to nonagricultural uses or the cancellation of Williamson Act contracts. This impact would be less than significant.

This impact would be similar to Impact Ag-3 (CP1); however, the extent of the impact would be greater under CP3 than under CP1 and CP2 because alteration of the flow regime of the Sacramento River would be greater. This impact

would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Ag-4 (CP3): Direct and Indirect Conversion of Forest Land to Nonforest Uses Along the Upper Sacramento River Altered flow regimes associated with project implementation under CP3 could adversely affect forest land along the upper Sacramento River. The altered flow regime could affect oak woodland communities by prolonging inundation and changing the availability of soil moisture; however, these effects are unclear and may not all prove to be adverse. Changes in the magnitude of intermediate and large flows would likely be sufficient to alter the dynamics and structure of forests in the riparian corridor along the upper Sacramento River in the future. However, changes in the flow regime would not reduce the extent of riparian forest. Therefore, implementing CP3 would not result in the conversion of forest land to nonforest uses. This impact would be less than significant.

This impact would be similar to Impact Ag-4 (CP1); however, the extent of the impact would be greater under CP3 than under CP1 and CP2 because alteration of the flow regime of the Sacramento River would be greater. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta and CVP/SWP Service Areas

Impact Ag-5 (CP3): Direct and Indirect Conversion of Important Farmland to Nonagricultural Uses and Cancellation of Williamson Act Contracts in the Extended Study Area Agricultural lands in the extended study area, including Important Farmland and Williamson Act contract lands, could be inundated or undergo soil saturation as a result of increased mean monthly river flows. Increases in Sacramento River stage (elevation) would be small. These increased flows would affect areas periodically inundated or saturated under existing conditions or the No-Action Alternative. The effects of this inundation would diminish with distance downstream. CP3 also would increase the reliability of the water supply by increasing water supplies for irrigation purposes primarily during dry and critical years. Therefore, implementing CP3 would not directly or indirectly result in the conversion of Important Farmland to nonagricultural uses or the cancellation of Williamson Act contracts. This impact would be less than significant.

This impact would be similar to Impact Ag-5 (CP1); however, the extent of the impact would be greater under CP3 than under CP1 and CP2 because alteration of the flow regime of the Sacramento River would be greater. In addition, CP3 would not include reserving storage capacity in Shasta Reservoir for increasing M&I deliveries during dry and critical years. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Ag-6 (CP3): Direct and Indirect Conversion of Forest Land to Nonforest Uses in the Extended Study Area Altered flow regimes associated with project implementation under CP3 could adversely affect riparian forest and oak woodlands. The altered flow regime could affect oak woodlands by prolonging inundation and changing soil moisture in some years; however, these effects are unclear and may not all prove to be adverse. Changes in the magnitude of intermediate and large flows would likely be sufficient to alter the dynamics and structure of the riparian forests along the upper Sacramento River in the future. However, changes in flow regime would not reduce the extent of riparian forest. Therefore, implementing CP3 would not result in the conversion of forest land to nonforest uses. This impact would be less than significant.

This impact would be similar to Impact Ag-6 (CP1); however, the extent of the impact would be greater under CP3 than under CP1 and CP2 because alteration of the flow regime of the Sacramento River would be greater. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CP4 and CP4A – 18.5-Foot Dam Raise, Anadromous Fish Focus with Water Supply Reliability

Like each of the alternatives discussed above, CP4 or CP4A would increase storage at Shasta Lake, thus changing the reservoir's full pool elevation and seasonal pool elevations, and the flow regime in the Sacramento River and potentially several other reservoirs and downstream waterways.

As under CP3, raising Shasta Dam 18.5 feet under CP4 or CP4A would increase the reservoir's full pool elevation by 20.5 feet and enlarge the reservoir's total storage capacity by 634,000 acre-feet. Raising the dam 18.5 feet would increase the reservoir's surface area at full pool by about 2,570 acres (9 percent). In general, the effect of this increase would be slight, given that the reservoir would exceed the current full pool elevation only during wetter-than-normal years. CP4A is identical to CP4 with the exception of Shasta Dam and reservoir operations. CP4 and CP4A have similar reservoir operations in that they each dedicate a portion of the new storage in Shasta Lake for fisheries purposes; however, the portion of this dedicated storage varies.

Approximately 378,000 acre-feet of the increased reservoir storage space of CP4 would be dedicated to increasing the supply of cold water for anadromous fish survival purposes. For CP4, operations for the remaining portion of increased storage (approximately 256,000 acre-feet) would be the same as in CP1, with 70,000 acre-feet reserved in dry years and 35,000 acre-feet reserved in critical years to specifically focus on increasing M&I deliveries. Water supply reliability under CP4 would be the same as under CP1. Implementing CP4 would help reduce estimated future agricultural water shortages in the CVP/SWP service areas by increasing water supplies for agricultural deliveries by at least 22,500 acre-feet per year in dry and critical years and increasing average annual deliveries by about 20,300 acre-feet per year.

Similarly, approximately 191,000 acre-feet of the increased reservoir storage space of CP4A would be dedicated to increasing the supply of cold water for anadromous fish survival purposes. For CP4A, operations for the remaining portion of increased storage (approximately 443,000 acre-feet) would be the same as in CP2, with 120,000 acre-feet reserved in dry years and 60,000 acre-feet reserved in critical years to specifically focus on increasing M&I deliveries. Water supply reliability under CP4A would be the same as under CP2. Implementing CP4A would help reduce estimated future agricultural water shortages in the CVP/SWP service areas by increasing water supplies for agricultural deliveries by at least 37,600 acre-feet per year in dry and critical years and increasing average annual deliveries by about 31,400 acre-feet per year.

The changes in flow and river stage on the upper Sacramento River associated with CP4 would be the same as the changes associated with CP1. The changes in flow and river stage on the upper Sacramento River associated with CP4A would be the same as the changes associated with CP2. CP4 and CP4A also would involve augmenting spawning gravel and restoring riparian, floodplain, and side-channel habitat at up to six potential locations in the upper Sacramento River.

Shasta Lake and Vicinity

Impact Ag-1 (CP4 and CP4A): Direct and Indirect Conversion of Important Farmland to Nonagricultural Uses and Cancellation of Williamson Act Contracts in the Vicinity of Shasta Lake No lands adjacent to Shasta Lake or in the immediate vicinity above Shasta Dam are designated by DOC as Important Farmland or under Williamson Act contracts. No impact would occur.

This impact would be the same as Impact Ag-1 (CP1) for CP4. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

This impact would be the same as Impact Ag-1 (CP2) for CP4A. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact Ag-2 (CP4 and CP4A): Direct and Indirect Conversion of Forest Land to Nonforest Uses in the Vicinity of Shasta Lake Inundation of land and removal, modification, or relocation of infrastructure under CP4 or CP4A would result in the conversion of forest land to nonforest uses. This impact would be significant for CP4 or CP4A.

This impact would be the same as Impact Ag-2 (CP3) and would be significant for CP4. Mitigation for this impact is not proposed in Section 10.3.5 because no feasible mitigation is available to reduce the impact to a less-than-significant level.

This impact would be the same as Impact Ag-2 (CP3) and would be significant for CP4A. Mitigation for this impact is not proposed in Section 10.3.5 because no feasible mitigation is available to reduce the impact to a less-than-significant level.

Upper Sacramento River (Shasta Dam to Red Bluff)
Impact Ag-3 (CP4 and CP4A): Direct and Indirect Conversion of Important Farmland to Nonagricultural Uses and Cancellation of Williamson Act Contracts Along the Upper Sacramento River Agricultural lands in the upper Sacramento River portion of the primary study area, including Important Farmland and Williamson Act contract lands, could be inundated as a result of increases in mean monthly river flows. The flow increases that would occur in some years would generally be small (5 percent or less) and would affect areas periodically inundated under existing conditions or the No-Action Alternative. The effects of increased flows would diminish with distance downstream. Both CP4 and CP4A would increase the reliability of the water supply by increasing water supplies for irrigation purposes, primarily during dry and critical years. In addition, there is no Important Farmland or Williamson Act contract land in the area proposed for gravel augmentation or within any of the potential restoration areas. Therefore, implementing CP4 or CP4A would not directly or indirectly result in the conversion of Important Farmland to nonagricultural uses or the cancellation of Williamson Act contracts. This impact would be less than significant for CP4 or CP4A.

This impact would be similar to Impact Ag-3 (CP1) for CP4. This impact would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

This impact would be similar to but slightly greater than Impact Ag-3 (CP1), because alteration of the flow regime of the Sacramento River would be slightly greater under CP2 than under CP1. This impact would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact Ag-4 (CP4 and CP4A): Direct and Indirect Conversion of Forest Land to Nonforest Uses Along the Upper Sacramento River Altered flow regimes associated with project implementation under CP4 or CP4A could adversely affect forest land along the upper Sacramento River. The altered flow regime could affect oak woodland communities by prolonging inundation and changing the availability of soil moisture; however, these effects are unclear and may not all prove to be adverse. Changes in the magnitude of intermediate and large flows would likely be sufficient to alter the dynamics and structure of forests in the riparian corridor along the upper Sacramento River in the future. However, changes in the flow regime would not reduce the extent of riparian forest. Therefore, the implementation of CP4 or CP4A would not result in the conversion of forest land to nonforest uses. This impact would be less than significant.

This impact would be similar to Impact Ag-4 (CP1) for CP4 and would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

This impact would be similar to but slightly greater than Impact Ag-4 (CP1) for CP4, because alteration of the flow regime of the Sacramento River would be slightly greater under CP2 than under CP1. This impact would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta and CVP/SWP Service Areas

Impact Ag-5 (CP4 and CP4A): Direct and Indirect Conversion of Important Farmland and Cancellation of Williamson Act Contracts to Nonagricultural Uses in the Extended Study Area Agricultural lands in the extended study area, including Important Farmland and Williamson Act contract lands, could be inundated or undergo soil saturation as a result of increased mean monthly river flows. Increases in Sacramento River stage (elevation) would be small. These increased flows would affect areas periodically inundated or saturated under existing conditions or the No-Action Alternative. The effects of this inundation would diminish with distance downstream. CP4 and CP4A would increase the reliability of the water supply by increasing water supplies for irrigation purposes, primarily during dry and critical years. Therefore, the implementation of CP4 or CP4A would not directly or indirectly result in the conversion of Important Farmland to nonagricultural uses or the cancellation of Williamson Act contracts. This impact would be less than significant for CP4 or CP4A.

This impact would be similar to Impact Ag-5 (CP1) for CP4 and would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

This impact would be similar to but slightly greater than Impact Ag-5 (CP1) for CP4A, because alteration of the flow regime of the Sacramento River would be slightly greater under CP2 than under CP1. In addition, CP2 would include reserving more storage capacity in Shasta Reservoir to specifically focus on increasing M&I deliveries during dry and critical years and a greater volume of dry and critical year and average annual water supply for agricultural water deliveries for the CVP/SWP service areas. Therefore, this impact would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact Ag-6 (CP4 and CP4A): Direct and Indirect Conversion of Forest Land to Nonforest Uses in the Extended Study Area Altered flow regimes associated with project implementation under CP4 or CP4A could adversely affect riparian forest and oak woodlands. The altered flow regime could affect oak woodlands by prolonging inundation and changing soil moisture in some years; however, these effects are unclear and may not all prove to be adverse. Changes in the magnitude of intermediate and large flows would likely be sufficient to alter the dynamics and structure of the riparian forests along the upper Sacramento River in the future. However, changes in flow regime would not reduce the extent of riparian forest. Therefore, the implementation of CP4 or CP4A would not result in the conversion of forest land to nonforest uses. This impact would be less than significant for CP4 or CP4A.

This impact would be similar to Impact Ag-6 (CP1) and would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

This impact would be similar to but slightly greater than Impact Ag-6 (CP1) for CP4A, because alteration of the flow regime of the Sacramento River would be slightly greater under CP2 than under CP1. This impact would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

CP5 – 18.5-Foot Dam Raise, Combination Plan

Like each of the alternatives discussed above, CP5 would increase storage at Shasta Lake, thus increasing the reservoir's full pool elevation and seasonal pool elevations and changing the flow regime in the Sacramento River and potentially several other reservoirs and downstream waterways.

As under CP3, raising Shasta Dam 18.5 feet under CP5 would increase the reservoir's full pool elevation by 20.5 feet and enlarge its total storage capacity by 634,000 acre-feet. Raising the dam 18.5 feet would increase the reservoir's surface area at full pool by about 2,570 acres (9 percent). In general, the effect of this increase would be slight, given that the reservoir would exceed the current full pool elevation only during wetter-than-normal years.

Shasta Dam's operational guidelines would continue essentially unchanged, except during dry and critical years, when 150,000 acre-feet and 75,000 acre-feet, respectively, of the increased storage capacity in Shasta Reservoir would be reserved to specifically focus on increasing M&I deliveries. Implementing CP5 would help reduce estimated future agricultural water shortages in the CVP/SWP service areas by increasing water supplies for agricultural deliveries by at least 66,100 acre-feet per year in dry and critical years and increasing average annual deliveries by about 50,900 acre-feet per year. Of all the alternatives, CP5 would provide the greatest water supply reliability for the CVP/SWP service areas and the largest amount of storage capacity reserved for increasing M&I deliveries. CP5 also would involve augmenting spawning gravel and restoring riparian, floodplain, and side-channel habitat at up to six potential locations in the upper Sacramento River. CP5 would also involve constructing additional fish habitat in and along the shoreline of Shasta Lake and along the lower reaches of its tributaries and increasing recreation opportunities at Shasta Lake.

Shasta Lake and Vicinity

Impact Ag-1 (CP5): Direct and Indirect Conversion of Important Farmland to Nonagricultural Uses and Cancellation of Williamson Act Contracts in the Vicinity of Shasta Lake No lands adjacent to Shasta Lake or in the immediate vicinity above Shasta Dam are designated by DOC as Important Farmland or under Williamson Act contracts. No impact would occur.

This impact would be the same as Impact Ag-1 (CP1). No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact Ag-2 (CP5): Direct and Indirect Conversion of Forest Land to Nonforest Uses in the Vicinity of Shasta Lake Inundation of land and removal, modification, or relocation of infrastructure under CP5 would result in the conversion of forest land to nonforest uses. This impact would be significant.

This impact would be similar to Impact Ag-2 (CP3) and would be significant. Mitigation for this impact is not proposed in Section 10.3.5 because no feasible mitigation is available to reduce the impact to a less-than-significant level.

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact Ag-3 (CP5): Direct and Indirect Conversion of Important Farmland to Nonagricultural Uses and Cancellation of Williamson Act Contracts Along the Upper Sacramento River Agricultural lands in the upper Sacramento River portion of the primary study area, including Important Farmland and Williamson Act contract lands, could be inundated as a result of increases in mean monthly river flows. The flow increases that would occur in some years would generally be small (5 percent or less) and would affect areas periodically inundated under existing conditions or the No-Action Alternative. The effects of increased flows would diminish with distance downstream. CP5 also would increase the reliability of the water supply by increasing water supplies for irrigation purposes, primarily during dry and critical years. There is no Important Farmland or land under Williamson Act contract within the areas proposed for gravel augmentation, restoration, and improvements to recreational facilities. Therefore, implementing CP5 would not directly or indirectly result in the conversion of Important Farmland to nonagricultural uses or the cancellation of Williamson Act contracts. This impact would be less than significant.

This impact would be similar to Impact Ag-3 (CP1). In addition, none of the land in the areas proposed for gravel augmentation, restoration areas, and recreational facility improvements are Important Farmland or Williamson Act contract lands. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Ag-4 (CP5): Direct and Indirect Conversion of Forest Land to Nonforest Uses Along the Upper Sacramento River Altered flow regimes associated with project implementation under CP5 could adversely affect forest land along the upper Sacramento River. The altered flow regime could affect oak woodland communities by prolonging inundation and changing the availability of soil moisture; however, these effects are unclear and may not all prove to be adverse. Changes in the magnitude of intermediate and large flows would likely be sufficient to alter the dynamics and structure of forests in the riparian corridor along the upper Sacramento River in the future. However, changes in the flow regime would not reduce the extent of riparian forest.

Therefore, implementing CP5 would not result in the conversion of forest land to nonforest uses. This impact would be less than significant.

This impact would be similar to Impact Ag-4 (CP1) and would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta and CVP/SWP Service Areas
Impact Ag-5 (CP5): Direct and Indirect Conversion of Important Farmland to Nonagricultural Uses and Cancellation of Williamson Act Contracts in the Extended Study Area Agricultural lands in the extended study area, including Important Farmland and Williamson Act contract lands, could be inundated for undergo soil saturation as a result of increased mean monthly river flows. Increases in Sacramento River stage (elevation) would be small. These increased flows would affect areas periodically inundated or saturated under existing conditions or the No-Action Alternative. The effects of this inundation would diminish with distance downstream. CP5 also would increase the reliability of the water supply by increasing water supplies for irrigation purposes, primarily during dry and critical years. Therefore, implementing CP5 would not directly or indirectly result in the conversion of Important Farmland to nonagricultural uses or the cancellation of Williamson Act contracts. This impact would be less than significant.

This impact would be similar to Impact Ag-5 (CP1); however, CP5 would provide the greatest water supply reliability for the CVP/SWP service areas and the largest amount of storage capacity in Shasta Reservoir reserved to focus on increasing M&I deliveries. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Ag-6 (CP5): Direct and Indirect Conversion of Forest Land to Nonforest Uses in the Extended Study Area Altered flow regimes associated with project implementation under CP5 could adversely affect riparian forest and oak woodlands. The altered flow regime could affect oak woodlands by prolonging inundation and changing soil moisture in some years; however, these effects are unclear and may not all prove to be adverse. Changes in the magnitude of intermediate and large flows would likely be sufficient to alter the dynamics and structure of the riparian forests along the upper Sacramento River in the future. However, changes in flow regime would not reduce the extent of riparian forest. Therefore, implementing CP5 would not result in the conversion of forest land to nonforest uses. This impact would be less than significant.

This impact would be similar to Impact Ag-6 (CP1) and would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

10.3.5 Mitigation Measures

Table 10-9 presents a summary of mitigation measures for agricultural and forest resources.

No-Action Alternative

Under the No-Action Alternative, no action would be taken, including implementation of mitigation measures; rather, existing conditions would continue to change into the future. No mitigation measures are required for the No-Action Alternative. Thus, Impacts Ag-1 (No-Action), Ag-3 (No-Action), and Ag-5 (No-Action) would be significant and unavoidable.

Table 10-9. Summary of Mitigation Measures for Agriculture and Important Farmland

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/CP4A	CP5
Impact Ag-1: Direct and Indirect Conversion of Important Farmland to Nonagricultural Uses and Cancellation of Williamson Act Contracts in the Vicinity of Shasta Lake	LOS before Mitigation	PS	NI	NI	NI	NI	NI
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	SU	NI	NI	NI	NI	NI
Impact Ag-2: Direct and Indirect Conversion of Forest Land to Nonforest Uses in the Vicinity of Shasta Lake	LOS before Mitigation	NI	S	S	S	S	S
	Mitigation Measure	None required.	No feasible mitigation is available to reduce impact.				
	LOS after Mitigation	NI	SU	SU	SU	SU	SU
Impact Ag-3: Direct and Indirect Conversions of Important Farmland to Nonagricultural Uses and Cancellation of Williamson Act Contracts Along the Upper Sacramento River	LOS before Mitigation	PS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	SU	LTS	LTS	LTS	LTS	LTS

Table 10-9. Summary of Mitigation Measures for Agriculture and Important Farmland (contd.)

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/CP4A	CP5
Impact Ag-4: Direct and Indirect Conversion of Forest Land to Nonforest Uses Along the Upper Sacramento River	LOS before Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
Impact Ag-5: Direct and Indirect Conversion of Important Farmland to Nonagricultural Uses and Cancellation of Williamson Act Contracts in the Extended Study Area	LOS before Mitigation	PS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	SU	LTS	LTS	LTS	LTS	LTS
Impact Ag-6: Direct and Indirect Conversion of Forest Land to Nonforest Uses in the Extended Study Area	LOS before Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS

Key:
CP = Comprehensive Plan
LOS = level of significance
LTS = less than significant
NI = no impact
PS = potentially significant
S = significant
SU = significant and unavoidable

CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

No mitigation is required for Impact Ag-1 (CP1) or for Impacts Ag-3 (CP1) through Ag-6 (CP1). No feasible mitigation measures are available at the time of preparation of this EIS to reduce Impact Ag-2 (CP1) to a less-than-significant level (i.e., to mitigate conversion of forest land to nonforest uses in the vicinity of Shasta Lake). Therefore, Impact Ag-2 (CP1) would be significant and unavoidable.

CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

No mitigation is required for Impact Ag-1 (CP2) or for Impacts Ag-3 (CP2) through Ag-6 (CP2). As discussed above for CP1, no feasible mitigation measures are available at the time of preparation of this EIS to reduce Impact Ag-2 (CP2) to a less-than-significant level (i.e., to mitigate conversion of forest land to nonforest uses in the vicinity of Shasta Lake). Therefore, Impact Ag-2 (CP2) would be significant and unavoidable.

CP3 – 18.5-Foot Dam Raise, Agricultural Water Supply Reliability and Anadromous Fish Survival

No mitigation is required for Impact Ag-1 (CP3) or for Impacts Ag-3 (CP3) through Ag-6 (CP3). As discussed above for CP1, no feasible mitigation measures are available at the time of preparation of this EIS to reduce Impact Ag-2 (CP3) to a less-than-significant level (i.e., to mitigate conversion of forest land to nonforest uses in the vicinity of Shasta Lake). Therefore, Impact Ag-2 (CP3) would be significant and unavoidable.

CP4 and CP4A – 18.5-Foot Dam Raise, Anadromous Fish Focus with Water Supply Reliability

No mitigation is required for Impact Ag-1 (CP4 and CP4A) or for Impacts Ag-3 (CP4 and CP4A) through Ag-6 (CP4 and CP4A). As discussed above for CP1, no feasible mitigation measures are available at the time of preparation of this EIS to reduce Impact Ag-2 (CP4 and CP4A) to a less-than-significant level (i.e., to mitigate conversion of forest land to nonforest uses in the vicinity of Shasta Lake). Therefore, Impact Ag-2 (CP4 and CP4A) would be significant and unavoidable.

CP5 – 18.5-Foot Dam Raise, Combination Plan

No mitigation is required for Impact Ag-1 (CP5) or for Impacts Ag-3 (CP5) through Ag-6 (CP5). As discussed above for CP1, no feasible mitigation measures are available at the time of preparation of this EIS to reduce Impact Ag-2 (CP5) to a less-than-significant level (i.e., to mitigate conversion of forest land to nonforest uses in the vicinity of Shasta Lake). Therefore, Impact Ag-2 (CP5) would be significant and unavoidable.

10.3.6 Cumulative Effects

Chapter 3, "Considerations for Describing the Affected Environment and Environmental Consequences," discusses overall cumulative impacts methodology related to the action alternatives, including the relationship to the CALFED Bay-Delta Program Programmatic EIS/EIR cumulative impacts analysis, qualitative and quantitative assessment, past and future actions in the study area, and significance criteria.. Table 3-1, "Present and Reasonably Foreseeable Future Actions Included in the Analysis of Cumulative Impacts, by Resource Area," in Chapter 3, lists the present and reasonably foreseeable future projects considered quantitatively and qualitatively within the cumulative impacts analysis. This cumulative impacts analysis accounts for potential project impacts combined with the impacts of existing facilities, conditions, land uses, and reasonably foreseeable actions expected to occur in the study area on a qualitative and quantitative level.

Past and present impacts on agriculture and forest lands are from changes in land use, oversubscription of surface and groundwater supplies, economic drivers, pests and disease, and wildland fires. All of the projects listed in Table 3-1 under Quantitative Analysis, would affect agriculture in the future, some beneficially, some adversely, and some both beneficially and adversely. These projects affect agriculture by altering water supplies available for agricultural uses, either directly or indirectly. However, because the SLWRI would improve agricultural water supplies, none of the action alternatives would contribute to a cumulative impact on agricultural resources in the primary or extended study area. Also, none of the projects listed in Table 3-1 under Quantitative Analysis, would have an adverse effect on forest resources, therefore there would be no quantitative cumulative impact on these resources from any of the action alternatives.

The projects listed in Table 3-1 for Qualitative Analysis also both benefit and adversely affect agricultural and forest land resources through alteration of waters supplies and converting agricultural land to other land uses. Example projects include, but are not limited to North Delta Flood Control and Ecosystem Restoration Project, Bay-Delta Conservation Plan, Dutch Slough Tidal Marsh Restoration Project, In-Delta Storage Program, and San Luis Drainage Reevaluation Program. California's demand for water for irrigation and other uses is expected to continue to increase, while the water supply will likely become less reliable. Future implementation of the related projects considered in this analysis of cumulative impacts would convert agricultural land, including Important Farmland, to nonagricultural uses. With or without implementation of the proposed action, the significant cumulative losses of agricultural resources, including Important Farmland, that have occurred in the primary and extended study areas from past projects—and that would continue as a result of planned future projects—are considerable.

Agricultural lands in the upper Sacramento River portion of the primary study area and in the extended study area, including Important Farmland and

Williamson Act contract lands, could be inundated as a result of increases in mean monthly river flows under any of the project alternatives. The flow increases that would occur in some years would generally be expected to be small (5 percent or less) and would affect areas periodically inundated under existing conditions or the No-Action Alternative. The effects of increased flows would diminish with distance downstream. Any of the project alternatives also would increase the reliability of the water supply by increasing water supplies for irrigation purposes, primarily during dry and critical years. Therefore, implementing any of the project alternatives would not directly or indirectly result in the conversion of Important Farmland to nonagricultural uses or the cancellation of Williamson Act contracts. This impact would be less than significant. Implementation of any of the project alternatives would not result in a considerable incremental contribution to a cumulatively significant impact associated with the conversion of Important Farmland to nonagricultural uses or the cancellation of Williamson Act contracts.

No operational changes would occur that would directly convert forest land to nonforest uses along the upper Sacramento River. However, CVP and SWP water storage, conveyance, and deliveries would change because of several reasonably foreseeable actions that would occur with or without enlargement of Shasta Dam. The resulting changes in flow regime would likely result in minimal adverse effects on riparian forest and oak woodlands. Several management and restoration plans and programs would implement actions that would largely offset those adverse effects. Although there would be reasonably foreseeable projects that would restore forest land or put land into agricultural production, there would be an overall significant cumulative effect on Important Farmlands and forest lands. The effects of climate change on operations at Shasta Lake could potentially cause changes in conditions for agricultural land and forest land in downstream areas. As described in the Climate Change Modeling Appendix, climate change could affect future demand for agricultural water by leading to increased rates of evapotranspiration and increasing the length of the growing season. On the other hand, increased precipitation could decrease overall water demand, depending on which adaptation strategies are used by agriculture and municipalities and how much more efficiently plants use water when carbon dioxide concentrations are higher. Crop types, planting cycles, time of planting, and crop productivity may change as a result of climate change, although a consensus has not been reached on how changes will occur. As stated previously in this section, increases in California’s demand for water and forecast reductions in water supply could lead to increased pressure to convert Important Farmland to other nonagricultural uses and cancel Williamson Act contracts.

In addition, changes to forest land and land cover could affect climate change. As stated in the Climate Change Modeling Appendix, deforestation and land cover conversion have also been identified as contributing to global warming by reducing the Earth’s capacity to remove carbon dioxide from the air and altering the Earth's albedo or surface reflectance, allowing more solar radiation to be absorbed.

In the primary study area, forest land would be affected by inundation of land and removal, modification, or relocation of infrastructure in the vicinity of Shasta Dam. Implementing any of the project alternatives (CP1–CP5) would result in the conversion of forest land to nonforest uses in the vicinity of Shasta Dam. No feasible mitigation exists to create a similar area of forest land to replace the area of forest land that would be inundated or converted to nonforest uses by relocation of facilities. Although reforestation could occur at a small scale over hundreds of years, the acreage of forest land converted to nonforest uses, including by reservoir inundation, is too large of a scale for successful and feasible reforestation. Therefore, implementing any of the project alternatives would result in a cumulatively considerable incremental contribution to a cumulative impact related to conversion of forest land to nonforest uses. However, most of this area remains substantially in forest land and has not been converted to nonforest uses. Therefore, the overall impact would not be cumulatively significant.

In the extended study area, altered flow regimes associated with implementation of any of the project alternatives could affect forest land. The altered flow regime could affect oak woodlands by prolonging inundation and changing the availability of soil moisture in some years; however, these effects are unclear and may not all prove to be adverse. Changes in the magnitude of intermediate and large flows would likely be sufficient to alter the dynamics and structure of the riparian forest along the upper Sacramento River in the future. However, changes in flow regime would not reduce the extent of riparian forest. Therefore, implementing any of the project alternatives would not result in the conversion of forest land to nonforest uses. Therefore, the project alternatives would not result in a cumulatively considerable incremental contribution to a significant cumulative impact related to conversion of forest land to nonforest uses.

As stated previously, climate change could result in changes to conditions for agricultural land and forest land in downstream areas. However, implementing any of the project alternatives would promote improvements in the reliability of CVP water supply deliveries. Thus, the project alternatives would not result in a cumulatively considerable incremental contribution to a significant cumulative impact related to future demands for, and availability of, agricultural water.

Implementing any of the project alternatives would result in a cumulatively considerable incremental contribution to a cumulative impact related to conversion of forest land to nonforest uses. However, most of this area remains substantially in forest land and has not been converted to nonforest uses. Thus, when added to the anticipated effects of climate change, raising Shasta Dam would not have a significant cumulative effect on climate change resulting from changes to forest land and land cover.

This page left blank intentionally.

Chapter 11
Fisheries and Aquatic Ecosystems

11.1 Affected Environment

This section describes the affected environment related to fisheries and aquatic ecosystems for the dam and reservoir modifications proposed under SLWRI action alternatives. For a more in-depth description of the affected environment, see the *Fisheries and Aquatic Ecosystems Technical Report*.

11.1.1 Aquatic Habitat

Shasta Lake and Vicinity

Water resources development, including the construction of dams and diversions, has affected the hydrology, geomorphology, and ecology of the watershed. Before the construction of Shasta Dam, the Sacramento River typically experienced large fluctuations in flow driven by winter storms, with late-summer flows averaging 3,000 cubic feet per second (cfs) or less. These fluctuations and periodic flows moved large amounts of sediment and gravel out of the mountainous tributaries and down the Sacramento River. The completion of Shasta Dam in 1945 resulted in general dampening of historic high and low flows, reducing the timing, magnitude, and duration of winter floods while maintaining higher summer flows between 7,000 and 13,000 cfs. The annual volume of flow in the Sacramento River continues to vary significantly from year to year. However, average monthly flows following the construction of Shasta Dam no longer exhibit pronounced seasonal winter highs and summer lows. This is primarily because of winter flood control operations that have reduced peak flood flows, and summer releases made for water supply purposes.

The current composition and distribution of fish species inhabiting the study area reflect habitat conditions, the historic fishery, the operational effects of Shasta Dam, effects of dams on several of the upstream tributaries, and the introduction of nonnative species.

The distribution and productivity of organisms and aquatic habitats of Shasta Lake are greatly affected by the reservoir's dynamic seasonal surface elevation fluctuations and thermal stratification. The reservoir's flood control, water storage, and water delivery operations typically result in declining water elevations during the summer through the fall months, rising or stable elevations during the winter months, and rising elevations during the spring months and sometimes into the early-summer months, while storing precipitation and snowmelt runoff. During summer months, the relatively warm surface layer within the lake favors warm-water fishes such as bass and catfish. Deeper layers are cooler and are suitable for cold-water species. Shasta Lake is classified as a cool-water, mesotrophic, monomictic reservoir because it is moderately productive and has one period of mixing each year, although it never completely turns over (Bartholow et al. 2001). Shasta Lake tributary fish species comprise several native and nonnative species and have been managed to favor naturally produced ("wild") and stocked (hatchery-cultured) native and nonnative trout species (Rode 1989, Moyle 2002, Rode and Dean 2004). Major assemblages of non-fish aquatic animal species include benthic macroinvertebrates and zooplankton communities. Climate conditions and reservoir storage volume are the two most influential factors affecting cold-water habitat and primary productivity in Shasta Lake (Bartholow et al. 2001). Cold-water habitat provided by Shasta Lake is a function of the total storage and associated surface area provided by Shasta Lake. This relationship is influenced by variation in the water surface elevation (WSEL) throughout the year. Variation in WSEL is a function of water demand, water quality requirements, and inflow, and WSEL can change based on the water year type.[1] Typically, primary production in reservoirs is associated with storage volumes when all other factors are held constant (Stables et al. 1990). Increased storage and the corresponding increase in surface area results in a greater total biomass and a greater abundance of plankton and fish, because available habitat area is increased.

Upper Sacramento River (Shasta Dam to Red Bluff)

The reach of the Sacramento River between Shasta Dam and Red Bluff has cool water temperatures because releases from Shasta and Keswick dams are regulated, and because the channel is stable and largely confined, with little meander. Riffle habitat with gravel substrates and deep pool habitats are more abundant than in reaches downstream, although they are still insufficient to support healthy salmonid populations. Immediately below Keswick Dam, the river is deeply incised in bedrock, with very limited riparian vegetation and limited functioning riparian ecosystems. Water temperatures are generally cool even in late summer because of the regulated dam releases. The reaches of the Sacramento River immediately downstream from Shasta Dam support populations of resident rainbow trout and other resident fish while the reach immediately downstream from Keswick Dam supports an abundant resident rainbow trout population, other resident fish, and provides holding habitat, spawning habitat, and juvenile rearing habitat for Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*O. mykiss*).

Near Redding, the river flows into the valley and the floodplain broadens. Historically, this area appears to have had wide expanses of riparian forests, but

[1] Throughout this document, water year types are defined according to the Sacramento Valley Index Water Year Hydrologic Classification unless specified otherwise.

much of the river's riparian zone is currently subject to urban encroachment and noxious-weed problems. This encroachment becomes quite extensive in the Anderson/Redding area, with homes placed directly within or adjacent to the riparian zone.

Despite net losses of gravel since construction of Shasta Dam, substrates in much of this reach contain gravel needed for spawning by salmonids. This gravel is derived mostly from the Central Valley Project Improvement Act (CVPIA) gravel augmentation program. This reach provides much of the remaining spawning and rearing habitat of several listed anadromous salmonids (i.e., species that spawn in freshwater after migrating as adults from marine habitat). The Livingston Stone Hatchery, located immediately downstream from Shasta Dam produces winter-run Chinook salmon while the Coleman National Fish Hatchery, located on Battle Creek at tributary to the Sacramento River downstream from Keswick Dam, produces both Chinook salmon and steelhead. The reach of the Sacramento River downstream from Keswick Dam provides spawning and juvenile rearing habitat for winter-run, spring-run, fall-run, and late fall-run Chinook salmon and Central Valley steelhead. For this reason, the Sacramento River between Shasta Dam and Red Bluff is one of the most sensitive and important stream reaches in California.

Three water control structures – Keswick Dam, the Anderson-Cottonwood Irrigation District Dam, and Red Bluff Pumping Plant (RBPP) – are located along the Sacramento River in this reach. A new state-of-the-art positive barrier fish screen for the RBPP was completed in 2012. The fish screen allows the Red Bluff Diversion Dam gates to remain open most of the year to facilitate upstream and downstream passage by adult and juvenile Chinook salmon, steelhead, sturgeon, and other fish. A temperature control structure has been installed at Shasta Dam to improve cold-water pool management for salmonids spawning and rearing in the main stem river downstream from Keswick Dam. Instream flow regulation to meet habitat requirements and seasonal water temperatures for salmonids and other fish, flood control, and water supply deliveries are controlled primarily through managed releases of water from Shasta Dam that subsequently pass downstream through Keswick Dam into the main stem Sacramento River.

The main tributaries to the Sacramento River between Shasta Dam and Red Bluff are Battle, Bear, Clear, Cow, and Cottonwood creeks. The primary land uses along the Sacramento River between Shasta Dam and RBPP are urban, residential, and agricultural.

Lower Sacramento River and Delta

The roughly 300 miles of the Sacramento River can be subdivided into distinct reaches. The reaches in the lower Sacramento River and Delta area are discussed separately because of differences in morphology, water temperature, and aquatic habitat functions.

Sacramento River from Red Bluff to Colusa In this reach, the Sacramento River functions as a large alluvial river with active meander migration through the valley floor. The river is classified as a meandering river, where relatively stable, straight sections alternate with more sinuous, dynamic sections (Resources Agency 2003). The active channel is fairly wide in some stretches and the river splits into multiple braided channels at many different locations, creating gravel islands, often with riparian vegetation. Historic bends in the river are visible throughout this reach and appear as scars of the historic channel locations; the riparian corridor and oxbow lakes are still present in many locations. The channel remains active and has the potential to migrate during times of high water. Point bars, islands, high and low terraces, instream woody cover, growth of early successional riparian plants, and other evidence of river meander and erosion are common in this reach. The channel has varying widths, and aquatic habitats consist of shallow riffles, deep runs, deep pools at meander bends, glides, and willow vegetated floodplain areas that become inundated during high flows.

Sacramento River from Colusa to the Delta The general character of the Sacramento River changes drastically downstream from Colusa from a dynamic and active meandering channel to a confined, narrow channel restricted from migration. Setback levees exist along portions of the river upstream from Colusa; however, the levees become much narrower along the river’s edge as the river continues south to the Delta. Agricultural lands are located directly adjacent to the levees, which have cut the river off from most of its riparian corridor, especially on the east side of the river. Between Colusa and the Delta, Sacramento River levees are mostly lined with riprap, allowing the river no erodible substrate. Because the river is confined by levees, the trapezoidal channel width is fairly uniform (typically around 500 and 600 feet wide) and river bends are static. Depth profiles and substrate composition are fairly uniform throughout the reach, so aquatic habitats are fairly homogenous.

Several major flood control bypass facilities, including the Sutter and Yolo bypasses, are managed to provide flood protection for local municipalities and agricultural areas, and also provide important seasonal floodplain habitat that support juvenile salmonid rearing, habitat for Sacramento splittail (*Pogonichthys macrolepidotus*) spawning and larval rearing, and food production that passes downstream into the Sacramento River and Delta. Multiple water diversion structures move floodwaters into floodplain bypass areas during high-flow events. A large number of screened and unscreened agricultural irrigation diversions occur within the reach.

Tributaries to the Lower Sacramento River The lower reaches of primary tributaries to the lower Sacramento River are characterized here because of the potential for project effects on flows and associated flow-related effects on fish species of management concern. These potential flow changes, however, are minimized by upstream CVP and SWP reservoir operations and flow increases from tributary inflows and return flows from diversions and flood bypasses.

Lower Feather River Aquatic habitats found in the lower Feather River vary as the river flows from its release at the DWR Oroville Dam facilities down to the confluence with the Sacramento River at Verona. Included in the Oroville facilities are a low-flow channel and a high-flow channel. Under the Federal Energy Regulatory Commission license, DWR maintains an approximate 8-mile low-flow channel at 700 to 800 cfs. The low-flow channel at the upper extent of the lower Feather River contains mainly riffles and runs, which provide spawning habitat for the majority of Chinook salmon and steelhead. Also present in the low-flow channel is a series of remnant gravel pit pools/ponds that connect to the main channel.

This stretch of the Feather River is mostly confined by levees as it flows through the city of Oroville. Instream flows and water temperature management in the low-flow section of the river are managed by releases from Oroville Dam in compliance with the Federal Energy Regulatory Commission (Project 2100) requirements, and NMFS biological opinion (BO), and other regulatory requirements. From the downstream end of the low-flow channel, the river is fairly active and meanders its way south to Marysville. However, the high flow channel is bordered by active farmland, which confines the river to an incised channel in certain stretches. Some areas of adjacent farmlands have been restored to floodplain habitat with the construction of setback levee. The high flow channel that extends downstream to the Sacramento River also provides habitat for a variety of resident and migratory fish, as well as a migratory corridor, on the lower Feather River. The Feather River also supports wetland habitat for resident fish and wildlife. The Feather River Fish Hatchery, located immediately downstream from Oroville Dam, produces fall-run and spring-run Chinook salmon and steelhead.

Lower American River Flows in the lower American River (below Folsom and Nimbus dams) provide habitat for anadromous and resident fish species. The lower American River supports spawning and juvenile rearing by fall-run Chinook salmon and steelhead (although oversummering water temperatures limit juvenile steelhead rearing habitat) as well as a variety of resident fish and migratory fish, including American shad (*Alosa sapidissima*). The river is fairly low gradient and is composed of riffle, run, glide, and pool habitats. Folsom and Nimbus Dams, as well as a number of impoundments located further upstream in the watershed have reduced gravel inputs to the system, but the lower American River contains large gravel bars and forks in many locations, leaving gravel/cobble islands within the channel. Instream flows in the lower American River are managed by Reclamation through operations of Folsom and Nimbus Dams to provide instream flows for fishery habitat, maintenance of stream temperatures, flood control, and downstream water supplies and water quality management in the Delta.

Hatcheries located on the lower American River produce fall-run Chinook salmon, steelhead, and resident trout. Most of the lower American River is surrounded by the American River Parkway, preserving the surrounding riparian zone. The river channel does not migrate to a large degree because the geologic composition has allowed the river to incise deep into sediments, leaving tall cliffs and bluffs adjacent to the river.

Sacramento River Floodplain Bypasses There are three major floodplain bypasses – the Butte Basin, Sutter Bypass, and Yolo Bypass – along the main stem Sacramento River. These bypasses operate with a total of 10 overflow structures (6 weirs, 3 flood relief structures, and an emergency overflow roadway) primarily to provide flood control and secondarily to provide access to broad, inundated floodplain habitat for salmon rearing and splittail spawning during wet years. In high-flow periods, the stage of the Sacramento River is elevated and water flows over the weirs into the bypasses. Although the bypasses serve as important seasonal habitat for juvenile salmonid rearing and splittail spawning, an alternative migration pathway, and for the production and transport of organic matter downstream into the river and Delta, the bypasses are primarily operated and managed for flood control during the winter and for agricultural production during the spring and summer.

Unlike other Sacramento River and Delta habitats, floodplains and floodplain bypasses are dewatered seasonally as high flows recede between late spring and autumn. This prevents introduced fish species from establishing year-round dominance except in perennial water sources (Sommer et al. 2003). Moreover, many of the native fish, such as Sacramento splittail, are adapted to spawn and rear in winter and early spring (Moyle 2002) during the winter flood pulse. Introduced fish typically spawn between late spring and summer, when most of the floodplain is not available to them.

Butte Basin The Butte Basin lies east of the Sacramento River and extends from the Butte Slough outfall gates near Meridian to Big Chico Creek near Chico Landing. Flood flows are diverted out of the Sacramento River into the Butte Basin and Sutter Bypass via several designated overflow areas (i.e., low points along the east side of the river) that allow high flood flows to exit the Sacramento River channel.

Sutter Bypass The Sutter Bypass is a narrow floodwater bypass that conveys Sacramento River flood flows from the Butte Basin and the Tisdale Weir. The bypass area is an expansive land area in Sutter County used mainly for agriculture. In times of high water (when the stage exceeds 45.5 feet), Sacramento River water enters the bypass through the Butte Slough outfall and the Tisdale Weir and inundates the bypass with as much as 12 feet of water. The Sutter Bypass, in turn, conveys flows to the lower Sacramento River region at the Fremont Weir near the confluence with the Feather River and into the Sacramento River and the Yolo Bypass (USACE and The Reclamation Board 2002).

Yolo Bypass The Yolo Bypass is an approximately 59,000-acre land area that conveys Sacramento River floodwaters around Sacramento during times of high runoff. Sacramento River flow is diverted into the bypass when the river stage exceeds 33.5 feet (corresponding to 56,000 cfs at Verona). Diversion of most floodwaters from the Sacramento River, Sutter Bypass, and Feather River into the Yolo Bypass from Fremont Weir controls Sacramento River flood stages at Verona. During large flood events, up to 80 percent of Sacramento River flows are diverted into the bypass. The Yolo Bypass subsequently drains back into the Sacramento River in the vicinity of Cache Slough, which is located just upstream from Rio Vista. Cache Slough and the adjacent Sacramento Deep Water Ship Channel have been found to provide habitat year-round for delta smelt (*Hypomesus transpacificus*) as well as other fish. Efforts are currently underway to enhance aquatic habitat for juvenile salmonids, delta smelt, and other fish in the Yolo Bypass/Cache Slough complex.

Sacramento Deep Water Ship Channel The Sacramento Deep Water Ship Channel is a tidally influenced canal that is about 30 feet deep, 200 feet wide, and 43 miles long. It flows from the Port of Sacramento into the Sacramento River, which flows into San Francisco Bay. The channel was completed in 1969 and is primarily used to transport agricultural products. Due to manipulations to the channel, such as dredging, it tends to have low dissolved oxygen (DO) concentrations. Delta smelt spawn in and around the Sacramento Deep Water Ship Channel, and juvenile delta smelt are found in the channel (Baxter 2010).

Lower San Joaquin and Stanislaus Rivers The lower San Joaquin River is characterized by a relatively wide (approximately 300-foot) channel with little canopy or overhead vegetation and minimal bank cover. Aquatic habitat in the San Joaquin River is characterized primarily by slow-moving glides and pools, is depositional in nature, and has limited water clarity and habitat diversity. The Stanislaus River provides habitat for fall-run Chinook salmon spawning and juvenile rearing as well as a small population of resident trout and steelhead. Instream flows on the river are managed by Reclamation through releases from New Melones Reservoir for fishery habitat, water temperature management, flood control, and water supplies. Many of the fish species using the lower San Joaquin River use this lower segment of the river to some degree, even if only as a migratory pathway to and from upstream spawning and rearing areas. The lower river also is used by certain fish species (e.g., delta smelt) that make little to no use of areas in the upper segment of the river (see the Delta discussion below).

Aquatic habitats in the lower Stanislaus River vary longitudinally and provide fish spawning, rearing, and/or migratory habitat for a diverse assemblage of common Central Valley native and nonnative fish species. Aquatic habitats include riffles, runs, pools, and glides. Floodplain and associated riparian habitat also varies with the development of levees and encroachment of agriculture and urban uses. There is no fish hatchery located on the Stanislaus River although salmonids produced in hatcheries on other rivers (e.g., Merced River Fish Hatchery) have periodically been released into the Stanislaus River.

Water temperature and flows in both the lower San Joaquin and Stanislaus river systems are highly altered and are managed for flood control and water supply purposes.

Sacramento-San Joaquin Delta The Delta and Suisun Bay, on the western edge of the Delta, are located at the confluence of the Sacramento and San Joaquin rivers and may be considered to represent the most important, complex, and controversial geographic area for both anadromous and resident fisheries production and distribution of California water resources for numerous beneficial uses. The Delta's channels are used to transport water from upstream reservoirs to the south Delta, where Federal and State export facilities (Jones Pumping Plant and Harvey O. Banks Delta Pumping Plant, respectively) pump water into CVP and SWP canals, respectively.

Environmental conditions in the Delta depend primarily on the physical structure of Delta channels, inflow volume and source, Delta Cross Channel (DCC) operations, Delta exports and diversions, and tides. The CVP affects Delta conditions primarily through control of upstream storage and diversions, Delta exports and diversions, and DCC operations. These factors also determine outflow and the location of the low salinity zone (LSZ), which is an area of high organic carbon that is critically important to a number of fish and invertebrate species, as well as to the overall ecology of the Delta and Suisun Bay. The location of the LSZ in the estuary is typically denoted as the distance in kilometers upstream from the Golden Gate Bridge where the 2-practical-salinity-unit bottom salinity isohaline is located which is commonly referred to as the X2 location. The location of X2 is downstream in the Suisun Bay area (e.g., adjacent to Chipps or Roe Islands) when Delta outflow is relatively high and further upstream in the lower Sacramento and San Joaquin Rivers (e.g., Collinsville) when Delta outflow is reduced (Kimmerer 2004, Cloern and Jassby 2012). The location of X2 during the late winter and spring is managed in accordance with provisions of State Water Board Water Right Decision 1641 (D-1641). In addition to these physical factors, environmental conditions such as water temperature, predation, food production and availability, competition with introduced exotic fish and invertebrate species, and pollutant concentrations all contribute to interactive, cumulative conditions that have substantial effects on Delta fish populations.

Water development has changed the volume and timing of freshwater flows through the San Francisco Bay/Sacramento-San Joaquin Delta (Bay-Delta). Over the past several decades, the volume of the Bay-Delta's freshwater supply and Delta outflow from the estuary has been reduced by upstream diversions, in-Delta use, and Delta exports. As a result, the proportion of Delta outflow depleted by upstream and Delta diversions has grown substantially (Kimmerer 2004).

Water development has also altered the seasonal timing of flows passing into and through the Bay-Delta. Flows have decreased in April, May, and June and have increased slightly during the summer and fall (State Water Board 2012). Seasonal flows influence the transport of eggs and young organisms (e.g., zooplankton, fish eggs, larvae) through the Delta and into San Francisco Bay. Flows during the late winter and spring (e.g., February to June) play an especially important role in determining the reproductive success and survival of many estuarine species, including salmon, striped bass, American shad, delta smelt, longfin smelt (*Spirinchus thaleichthys*), splittail, and others (Stevens and Miller 1983, Stevens et al. 1985, Herbold 1994, Meng and Moyle 1995, Rosenfield 2010, Rosenfield and Baxter 2007, MacNally et al. 2010, Thomson et al. 2010).

An estimated 25 percent of all warm-water and anadromous sport fishing and 80 percent of California's commercial fishery depend on species that live in or migrate through the Delta. The Delta serves as a migration path for all Central Valley anadromous species returning to their natal rivers to spawn. Adult Chinook salmon move through the Delta during most months of the year. Salmon and steelhead juveniles depend on the Delta as transient rearing habitat during migration through the system to the ocean and could remain for several months, feeding in marshes, tidal flats, and sloughs. In addition, Delta outflow has been correlated to changes in the abundance and distribution of fish, such as green sturgeon and longfin smelt, and invertebrates in the bay through changes to salinity, currents, nutrient levels, and pollutant concentrations (Thomson et al. 2010, Mac Nally et al. 2010, Kimmerer 2002, Rosenfield and Baxter 2007, Rosenfield 2010). Delta smelt is a key species driving many of the ongoing water management decisions in the Delta (USFWS 2008).

Trinity River Sacramento River flow is augmented in average water years by the transfer of up to 1 million acre-feet of Trinity River water through Clear Creek and Spring Creek tunnels to Keswick Reservoir (Reclamation 2004). Flows in the Trinity River (below Lewiston Dam) are generally cold, providing habitat for anadromous and resident fish species. Aquatic habitats in the river consist of riffle, run, glide, and pool habitats. Fish habitat values have increased in quantity and quality through restoration activities that have taken place over the last several years. Implementation of the Trinity River Restoration Program is expected to further increase the value of the habitat below Lewiston Dam over the next 10 to 15 years (NMFS 2000).

CVP/SWP Service Areas

The CVP/SWP service areas contain primarily highly altered aquatic habitat types, including reservoirs, canals, ditches, and other manmade water conveyance structures/facilities. Agricultural land and urban development are the dominate land uses within these service areas. As a result of all these factors, the aquatic communities that occupy the habitats are highly adapted to these disturbed environments and are dominated by nonnative species.

11.1.2 Fish Species

Special-status aquatic species within the primary and extended study areas are listed in Table 11-1. These include animals that are legally protected or are otherwise considered sensitive by Federal, State, or local resource conservation agencies and organizations, and fish species of primary management concern (recreationally and/or commercially important species). The *Fisheries and Aquatic Ecosystems Technical Report* describes life histories and environmental/habitat requirements of special-status species, and information on seasonal timing of important life stages. The following text describes the fishes in the primary and extended areas that include special-status fish as well as other important species.

Table 11-1. Special-Status Aquatic Species Potentially Occurring in the Primary and Extended Study Areas

Species	Status[1]				Habitat	Potential to Occur in the Primary and Extended Study Areas
	USFWS/ NMFS	CDFW	USFS	MSCS Goals		
River lamprey *Lampetra ayresi*		SSC			Anadromous species that spends relatively little time in the ocean. Spawns in freshwater gravel substrates from February through May.	Occurs in the extended study areas in the Delta and Sacramento River and tributaries.
Pacific lamprey *Entosphenus tridentatus*			S		Anadromous species that spends 1-3 years in the ocean. Spawns in freshwater gravel substrates from March through July.	Occurs in portions of the primary study area in the Sacramento River below Keswick Dam and throughout the extended study area, including the Delta and major tributaries.
Central Valley steelhead *Oncorhynchus mykiss*	T			R	Requires cold, freshwater streams with suitable gravel for spawning; rears in seasonally inundated floodplains, rivers, tributaries, and Delta.	Occurs in the primary and extended study areas in the Sacramento River, tributaries, and Delta.
Central California Coast steelhead *Oncorhynchus mykiss*	T				Requires cold, freshwater streams with suitable gravel for spawning; rears in seasonally inundated floodplains, rivers, tributaries, and Delta.	Occurs in the extended study area in the lower Delta, Suisun Bay, and San Francisco Bay.

Table 11-1. Special-Status Aquatic Species Potentially Occurring in the Primary and Extended Study Areas (contd.)

Species	Status[1]				Habitat	Potential to Occur in the Primary and Extended Study Areas
	USFWS/ NMFS	CDFW	USFS	MSCS Goals		
Sacramento winter-run Chinook salmon *Oncorhynchus tshawytscha*	E	E		R	Requires cold, freshwater streams with suitable gravel for spawning; rears in seasonally inundated floodplains, rivers, tributaries, and Delta.	Occurs in the primary and extended study areas in the Sacramento River, tributaries, and Delta.
Central Valley spring-run Chinook salmon *Oncorhynchus tshawytscha*	T	T		R	Requires cold, freshwater streams with suitable gravel for spawning; rears in seasonally inundated floodplains, rivers, tributaries, and Delta.	Occurs in the primary and extended study areas in the Sacramento River, tributaries, and Delta.
Central Valley fall/late fall-run Chinook salmon *Oncorhynchus tshawytscha*		SSC	S	R	Requires cold, freshwater streams with suitable gravel for spawning; rears in seasonally inundated floodplains, rivers, tributaries, and Delta.	Occurs in the primary and extended study areas in the Sacramento River, tributaries, and Delta.
Southern Oregon Northern California Coasts Coho salmon *Oncorhynchus kisutch*	T	T			Requires cold, freshwater streams with suitable gravel for spawning; rears in inundated floodplains, edgewater, off-channel habitat, rivers, tributaries, and estuaries.	Occurs in the extended study area in the Trinity River.
Klamath Mountain Province steelhead *Oncorhynchus mykiss*			S		Requires cold, freshwater streams with suitable gravel for spawning; rears in seasonally inundated floodplains, rivers, tributaries, and Delta	Occurs in the extended study area in the Trinity River.
Southern DPS of the North American Green sturgeon *Acipenser medirostris*	T			R	Requires cold, freshwater streams with suitable gravel for spawning; rears in seasonally inundated floodplains, rivers, tributaries, and Delta.	Occurs in the primary and extended study areas in the Sacramento River, tributaries, and Delta.

Table 11-1. Special-Status Aquatic Species Potentially Occurring in the Primary and Extended Study Areas (contd.)

Species	Status[1]				Habitat	Potential to Occur in the Primary and Extended Study Areas
	USFWS/ NMFS	CDFW	USFS	MSCS Goals		
Delta smelt *Hypomesus transpacificus*	T	E		R	Spawns in tidally influenced freshwater wetlands and seasonally submerged uplands; rears in tidal marsh and Delta.	Occurs in the extended study area in the lower Sacramento River and the Delta.
Longfin smelt *Spirinchus thaleichthys*	P	T		R	Primary habitat is the open water of estuaries, both in seawater and freshwater areas, typically in the middle or deeper areas of the water column; spawn in estuaries in fresh or slightly brackish water over sandy or gravel substrates.	Occurs in the extended study area in the Delta.
Sacramento splittail *Pogonichthys macrolepidotus*	DT	SSC		R	Spawning and juvenile rearing occur from winter to early summer in shallow weedy areas inundated during seasonal flooding in the lower reaches and flood bypasses of the Sacramento River, including the Yolo Bypass.	Occurs in the primary and extended study areas in the Delta and Sacramento River, tributaries, and the Delta.
Hardhead *Mylopharodon conocephalus*		SSC	S	m	Spawning occurs in pools and side pools of rivers and creeks; juveniles rear in pools of rivers and creeks, and shallow to deeper water of lakes and reservoirs.	Occurs in the primary and extended study areas in freshwater portions of Sacramento River and tributaries.
San Joaquin roach *Lavinia symmetricus* sp.		SSC			Spawning occurs in pools and side pools of small rivers and creeks; juveniles rear in pools of small rivers and creeks.	Occurs in the extended study area in the San Joaquin River and tributaries and Delta.

Table 11-1. Special-Status Aquatic Species Potentially Occurring in the Primary and Extended Study Areas (contd.)

Species	Status[1]				Habitat	Potential to Occur in the Primary and Extended Study Areas
	USFWS/ NMFS	CDFW	USFS	MSCS Goals		
Rough sculpin *Cottus asperrimus*		FP			Prefers sand or gravel substrate in cool streams or reservoirs. Spawns in streams.	Potentially occurs in the Shasta Lake and vicinity portion of the primary study area in the Pit River and tributaries upstream from Shasta Lake.
Rainbow trout *Oncorhynchus mykiss*					Requires cold, freshwater streams with suitable gravel for spawning; rears in seasonally inundated floodplains, rivers, and tributaries.	Occurs in Shasta Lake, Keswick Reservoir, tributaries, and lakes.
Redband trout *Oncorhynchus mykiss stonei*			S		Requires cold, freshwater streams with suitable gravel for spawning; rears in seasonally inundated floodplains, rivers, and tributaries.	Occurs upstream from McCloud Dam.
Bull trout *Salvelinus confluentus*	T	E			Requires cold, freshwater streams with suitable gravel for spawning; rears in seasonally inundated floodplains, rivers, and tributaries.	Previously found in the McCloud River. Now considered extirpated from California.
California floater *Anodonta californiensis*			S		Potentially occurs in shallow areas of clean, clear ponds, lakes and rivers with sandy and silty substrate.	Potentially occurs in Shasta Lake, Keswick Reservoir, and tributaries.
Kneecap lanx *Lanx patelloides*			S		Potentially occurs in shallow areas of ponds, lakes, and rivers with sandy and silty substrate.	Potentially occurs in Shasta Lake, Keswick Reservoir, and tributaries.
Nugget pebblesnail *Fluminicola seminalis*			M		Potentially occurs in mixed conifer and conifer/woodland habitats (seeps, springs, and/or riverine habitats).	Potentially occurs in the Shasta Lake and vicinity portion of the primary study area in large creeks and rivers tributary to Shasta Lake.

Table 11-1. Special-Status Aquatic Species Potentially Occurring in the Primary and Extended Study Areas (contd.)

Species	Status[1]				Habitat	Potential to Occur in the Primary and Extended Study Areas
	USFWS/ NMFS	CDFW	USFS	MSCS Goals		
Potem pebblesnail *Fluminicola* sp. 14			M		Potentially occurs in mixed conifer and conifer/woodland habitats (seeps, springs, and/or riverine habitats)	Potentially occurs in the Shasta Lake and vicinity portion of the primary study area in tributaries to Shasta Lake.
Flat-top pebblesnail *Fluminicola* sp. 15			M		Potentially occurs in mixed conifer and conifer/woodland habitats (seeps, springs, and/or riverine habitats).	Potentially occurs in the Shasta Lake and vicinity portion of the primary study area in tributaries to Shasta Lake.
Shasta pebblesnail *Fluminicola* sp. 16			M		Potentially occurs in mixed conifer and conifer/woodland habitats (seeps, springs, and/or riverine habitats).	Potentially occurs in the Shasta Lake and vicinity portion of the primary study area in spring complexes associated with the Sacramento River upstream from Shasta Lake.
Disjunct pebblesnail *Fluminicola* sp. 17			M		Potentially occurs in mixed conifer and conifer/woodland habitats (seeps, springs, and/or riverine habitats).	Potentially occurs in the Shasta Lake and vicinity portion of the primary study area in spring complexes associated with the Sacramento River upstream from Shasta Lake.
Globular pebblesnail *Fluminicola* sp. 18			M		Potentially occurs in mixed conifer and conifer/woodland habitats (seeps, springs, and/or riverine habitats).	Potentially occurs in the Shasta Lake and vicinity portion of the primary study area in tributaries to Shasta Lake.
Cinnamon juga *Juga* (*Orebasis*) sp. 3			M		Potentially occurs in mixed conifer and conifer/woodland habitats (seeps, springs, and/or riverine habitats).	Potentially occurs in the Shasta Lake and vicinity portion of the primary study area in spring complexes associated with the Sacramento River upstream from Shasta Lake.
Black Juga *Juga nigrina*			S		Potentially occurs in mixed conifer and conifer/woodland habitats (seeps, springs, and/or riverine habitats).	Potentially occurs in the Shasta Lake and vicinity portion of the primary study area in spring complexes associated with the Sacramento River upstream from Shasta Lake.

Table 11-1. Special-Status Aquatic Species Potentially Occurring in the Primary and Extended Study Areas (contd.)

Species	Status[1]				Habitat	Potential to Occur in the Primary and Extended Study Areas
	USFWS/ NMFS	CDFW	USFS	MSCS Goals		
Canary duskysnail *Lyogyrus* sp. 3			M		Potentially occurs in mixed conifer and conifer/woodland habitats (seeps, springs, and/or riverine habitats).	Potentially occurs in the Shasta Lake and vicinity portion of the primary study area in spring complexes associated with the Pit River upstream from Shasta Lake.
Knobby rams-horn *Vorticefex* sp. 1			M		Potentially occurs in mixed conifer and conifer/woodland habitats (seeps, springs, and/or riverine habitats).	Potentially occurs in the Shasta Lake and vicinity portion of the primary study area in spring complexes associated with the Pit River upstream from Shasta Lake.

Sources: Vogel and Marine 1991; Moyle 2002; Wang 1986; NMFS 2005

Notes:
[1] Legal Status Definitions
Federal Listing Categories (USFWS/NMFS)
- DT Delisted from threatened status
- E Endangered (legally protected)
- T Threatened (legally protected)
- P Proposed for Federal Listing

State Listing Categories (CDFW)
- E Endangered (legally protected)
- SSC Species of Special Concern
- T Threatened (legally protected)
- FP Fully Protected

U.S. Forest Service (USFS)
- M Survey and Manage
- S Sensitive

Multi-Species Conservation Strategy (MSCS) Goals
- R Recovery. Recover species' populations within the MSCS focus area to levels that ensure the species' long-term survival in nature.
- m Maintain. Ensure that any adverse effects on the species that could be associated with implementation of CALFED actions will be fully offset through implementation of actions beneficial to the species (CALFED 2000a).

Key:
Delta = Sacramento-San Joaquin Delta
CDFW = California Department of Fish and Wildlife
DPS = Distinct Population Segment
MSCS = CALFED Bay-Delta Program's Multi-Species Conservation Strategy
NMFS = National Marine Fisheries Service
USFS = U.S. Forest Service
USFWS = U.S. Fish and Wildlife Service

Shasta Lake and Vicinity

Shasta Lake fish species include native and nonnative species, which are dominated by mostly introduced warm-water and cold-water species (Weidlein 1971) (Table 11-2). Major assemblages of non-fish aquatic animal species include benthic macroinvertebrates and zooplankton communities.

Table 11-2. Fish Species Known to Occur in the Primary Study Area

Common Name	Scientific Name	Distribution Within the Primary Study Area		
		Shasta Lake Tributaries	Shasta Lake/ Keswick Reservoir	Sacramento River – Keswick Dam to RBPP
Chinook salmon	*Oncorhynchus tshawytscha*		X	
winter-run				X
spring-run				X
fall-run				X
late fall-run				X
Rainbow trout	*Oncorhynchus mykiss*	X	X	X
Steelhead trout	*Oncorhynchus mykiss*			X
Brown trout	*Salmo trutta*	X	X	X
Green sturgeon	*Acipenser medirostris*			X
White sturgeon	*Acipenser transmontanus*	X	X	X
Pacific lamprey	*Entosphenus tridentata*			X
Western brook lamprey	*Lampetra richardsoni*			X
Sacramento sucker	*Catostomus occidentalis*	X	X	X
Sacramento pikeminnow	*Ptychocheilus grandis*	X	X	X
Sacramento splittail	*Pogonichthys macrolepidotus*			X
Hardhead	*Mylopharodon conocephalus*	X	X	X
Sacramento blackfish	*Orthodon microlepidotus*	X	X	
California roach	*Lavinia symmetricus*	X		X
Speckled dace	*Rhinichthys osculus*	X	X	
Golden shiner	*Notemigonus crysoleucas*	X	X	X
Carp	*Cyprinus carpio*	X	X	X
Channel catfish	*Ictalurus punctatus*	X	X	X
White catfish	*Ameiurus catus*		X	X
Brown bullhead	*Ameiurus nebulosus*		X	X
Black bullhead	*Ameiurus melas*		X	X
Riffle sculpin	*Cottus gulosus*	X	X	
Prickly sculpin	*Cottus asper*	X	X	X
Rough sculpin	*Cottus asperrimus*	X		
Pit sculpin	*Cottus pitensus*	X		
Bigeye marbled sculpin	*Cottus klamathensis macrops*	X		
Largemouth bass	*Micropterus salmoides*		X	X
Smallmouth bass	*Micropterus dolomieui*	X	X	X
Spotted bass	*Micropterus punctulatus*	X	X	X
Black crappie	*Pomoxis nigromaculatus*		X	X
White crappie	*Pomoxis annulauris*		X	X
Bluegill sunfish	*Lepomis macrochirus*		X	X
Green sunfish	*Lepomis cyanellus*	X	X	X
Threadfin shad	*Dorosoma petenense*		X	
Tule perch	*Hysterocarpus traski*	X	X	X
Tui chub	*Siphateles bicolor*	X	X	

Sources: Moyle 2002; Reclamation 2004; Reclamation 2014
Key:
RBPP = Red Bluff Pumping Plant

Cold-Water Species Shasta Lake and its tributaries provide very productive habitats for cold-water fish species, which typically prefer or require temperatures cooler than 70 degrees Fahrenheit (°F). During the cooler months, cold-water species such as rainbow trout, brown trout (*Salmo trutta*), and landlocked Chinook salmon may be found rearing throughout the lake; these species do not spawn in the lake, preferring to spawn in tributary streams though few Chinook salmon stocked in Shasta Lake have ever been observed to spawn in the reservoir tributaries (Zustak 2009). During the summer months, these cold-water species may be found rearing in association with the cold, deep hypolimnion and metalimnion layers within the reservoir, although the fish may make frequent forays into the epilimnion to feed on small prey fish and return to cooler depths to digest their prey (Finnell and Reed 1969, Koski and Johnson 2002, Moyle 2002, Quinn 2005).

Native species such as white sturgeon (*Acipenser medirostris* and *A. transmontanus*), hardhead (*Mylopharodon conocephalus)*, riffle sculpin (*Cottus gulosus*), Sacramento sucker (*Catostomus occidentalis*), and Sacramento pikeminnow (*Ptychocheilus grandis*) tend to reside in cooler water strata in the reservoir and in and near tributary inflows (Moyle 2002). Trout may also congregate near the mouths of the reservoir's tributaries, including the Sacramento River (upstream from Shasta Lake), McCloud River, Pit River, and Squaw Creek, at various times of the year seeking thermal refuge, foraging, and spawning, when conditions are favorable for these species.

Hatchery- and pen-reared trout and salmon are stocked in Shasta Lake several times each year to support the sport fishery. About 60,000 pounds of juvenile rainbow trout (*Oncorhynchus mykiss*) and about 50,000 subcatchable Chinook salmon are planted annually (Baumgartner 2008).

Climate conditions and reservoir storage volume are the two most influential factors affecting cold-water habitat and primary productivity in Shasta Lake (Bartholow et al. 2001). Cold-water habitat provided by Shasta Lake is a function of the total storage and associated surface area provided by Shasta Lake. This relationship is influenced by variation in the WSEL throughout the year. Variation in WSEL is a function of water demand and downstream instream flow releases, water quality requirements, and inflow. WSEL can change within and among years based on hydrology within the watershed, based on the water year type. Typically, primary production in reservoirs is associated with storage volumes when all other factors are held constant (Stables et al. 1990). Increased storage and the corresponding increases in surface area and aquatic habitat results in a greater total biomass and a greater abundance of plankton and fish, because available aquatic habitat area is increased.

Warm-Water Species The warm-water fish habitats of Shasta Lake occupy two ecological zones: the littoral (shoreline/rocky/vegetated) and the pelagic (open water) zones. The littoral zone lies along the reservoir shoreline down to the maximum depth of light penetration on the reservoir bottom, and supports populations of spotted bass (*Micropterus punctulatus*), smallmouth bass (*M. dolomieui*), largemouth bass (*M. salmoides*), black crappie (*Pomoxis nigromaculatus*), bluegill (*Lepomis macrochirus*), channel catfish (*Ictalurus punctatus*), and other warm-water species. Warm-water fish species are generally structure oriented and mostly occupy the littoral zone, however, some warm-water species like spotted bass will forage in the pelagic zone of Shasta Lake.

The upper, surface layer of the pelagic zone is the principal plankton-producing region of the reservoir. Plankton comprises the base of the food web for most of the reservoir's fish populations. Operation of the Shasta Dam temperature control device (TCD), which helps conserve the reservoir's cold-water pool by accessing warmer water for storage releases in the winter, spring, and early summer, may reduce zooplankton biomass in the epilimnion. However, operations of the TCD may result in some increased plankton production at deeper levels as a result of a slight warming of the hypolimnetic layers within the reservoir during the fall months (Bartholow et al. 2001).

Warm-water species, such as largemouth bass, smallmouth bass, spotted bass, and other sunfishes, were introduced into Shasta Lake and have become well established with naturally sustaining populations. Spotted bass are currently the dominant warm-water species in Shasta Lake (Baumgartner 2006). These warm-water fishes feed primarily on invertebrates while young and become predaceous on other fishes, including engaging in some cannibalism, as they grow. In Shasta Lake, threadfin shad (*Dorosoma petenense*), crayfish, and other invertebrates are most abundant in the diets of these fish (Saito et al. 2001). Spawning activity usually begins during late March or April when temperatures rise to around 60°F. Males generally build the nests in sand, fine gravel, rubble, or debris-covered bottoms at depths between 1 and 20 feet, which varies by species. Spotted bass and catfishes typically spawn at greater depths than the other warm-water species in Shasta Lake. Eggs generally hatch in 3 to 5 days at the predominant springtime water temperatures in Shasta Lake, and males guard the eggs and larvae for up to 4 weeks (Moyle 2002). Fry and juveniles disperse into shallow water and prefer areas with vegetation and large rubble as protective cover from predators (Moyle 2002, Ratcliff 2006).

The primary factors affecting warm-water fish abundance and production in Shasta Lake include seasonal reservoir fluctuations, availability of high-quality littoral habitat, and annual climate variations (Ratcliff 2006). The effect of sport fishery harvests on Shasta Lake warm-water fish populations is not well understood but is believed to be small with catch-and-release practices, although it is generally thought that overfishing of naturally reproducing populations by sport fisheries seldom limits fish abundance (Moyle 2002).

Reservoir level fluctuations, associated shoreline erosion, and suppression of shoreline and emergent vegetation are thought to generally be the most significant factors affecting warm-water fish production in reservoirs, including Shasta Lake (Moyle 2002, Parkos and Wahl 2002, Ratcliff 2006). Water level variations influence physical, chemical, and biological processes, which in turn affect fish populations. Reservoir drawdowns reduce water depths and influence thermal stratification and the resulting temperature, DO, and water chemistry profiles.

The typical seasonality of reservoir fluctuations on Shasta Lake can affect year-to-year reproductive success of littoral-spawning fishes, especially the black bass species, by influencing nesting behavior (e.g., abandonment of nests) and dewatering of nests containing eggs in years when reservoir levels decline during the spring and early summer months. Under these same conditions, juveniles may be forced to move to areas with less protection from predation or lower food production. In years when the reservoir rises rapidly and/or extensively during the spring and early summer months, submergence of active bass nests by more than 15 to 20 feet often results in high egg mortality (Stuber, Gebhart, and Maughan 1982, Lee 1999, Moyle 2002).

Shoreline and littoral vegetation are important warm-water fish habitat components for sustainable fishery production (Ratcliff 2006). Structural diversity (e.g., submerged trees, brush, rock, boulders, and rubble) provides shelter and feeding areas for fish. During construction of the reservoir, many trees and brush fields were cleared before inundation. Portions of the Pit River and Squaw Creek arms were not cleared, as evidenced by the large number of inundated trees observable in certain areas. Clearing efforts reduced the potential structural diversity of the inundated habitat. Vegetative clearing in many reservoirs has resulted in rocks, boulders, and man-made features (e.g., bridge pilings, riprap, marinas) being the only structural habitat features available, especially for bass and other warm-water fishes.

Annual reservoir fluctuations create highly variable conditions for establishment and maintenance of shoreline and littoral-zone vegetation and aquatic invertebrate communities that subsequently impose limitations on warm-water fish production. Exposed shoreline reservoir areas generally require 3 to 4 years to reestablish terrestrial vegetation. The absence of established, rooted aquatic vegetation is a common aquatic habitat factor that limits populations and fishery production for many fish species in reservoirs (Ploskey 1986, Moyle 2002).

The Shasta-Trinity National Forest (STNF), in cooperation with other Federal and State agencies and local nongovernmental organizations, has implemented a habitat improvement program at Shasta Lake. The objective of this program is to increase cover for warm-water fish. As the fishery management agency for Shasta Lake, CDFW prepared a Draft Management Plan for Shasta Lake in 1991. This plan, which has not been finalized, acknowledges the benefit to warm-water fish of structural enhancement projects.

STNF, CDFW, and nongovernmental organizations have used a variety of materials and techniques to construct structural enhancements (e.g., willow planting, brush structures) to provide warm-water fish habitat within the drawdown zone of Shasta Lake. The materials and techniques have varied because of differences in funding, available materials, site conditions (reservoir levels), longevity, and desired outcome.

According to Shasta-Trinity National Forest (STNF) aquatic biologists, brush structures constructed from whiteleaf manzanita (*Arctostaphylos manzanita)* have been the STNF's preferred means of structural enhancement since about 1990. These structures have been constructed in areas where manzanita is available near the shoreline, typically in a manner that provides varying degree of structural habitat as water levels change over time. The biologists have indicated that these structures have typically resulted in a threefold to tenfold increase in the abundance of warm-water fish in the treated areas (Ratcliff 2006; Zustak 2007).

Tributary Species The lower reaches of the tributaries draining to the reservoir provide spawning habitat for adfluvial fishes (i.e., fish that spawn in streams, but rear and grow to maturity in lakes) residing in Shasta Lake, as well as stream-resident fishes, with rainbow trout the principal game species. Accessible and suitable cold-water fish spawning habitat, including appropriate seasonal flows, depths, and gravel substrates, was observed in 5 percent of intermittent tributaries and nearly 70 percent of perennial tributaries to Shasta Lake surveyed in 2011 and 2012 (see *Fisheries and Aquatic Ecosystems Technical Report* for details). Most native fish species found in Shasta Lake may also inhabit the lower reaches of the tributaries. Several tributaries to Shasta Lake (e.g., Little Squaw Creek,[2] Little Backbone Creek) have been subjected to discharge from abandoned upslope copper mines. The Shasta Lake West Watershed analysis (Bachmann 2000) suggests that these creeks are "biologically dead" as a result of acid mine discharge from these mines. This watershed analysis also stated that "fish kills" have occurred in Shasta Lake in the vicinity of such tributaries during high runoff conditions. No fish were observed during 2012 in watersheds known to be affected by a legacy of mining and acidic, metal-laden mine drainage, including Little Squaw Creek and Little Backbone Creek, both located in the watershed to the immediate northwest of Shasta Dam, and Town Creek, near the Bully Hill Mine located in the Squaw Creek arm (Reclamation 2014).

The four main tributaries to Shasta Lake, which include the Sacramento River, McCloud River, Squaw Creek, and Pit River, are renowned for their high-quality recreational trout fisheries. Each of these streams drains considerable watershed areas comprising mixed conifer forests in the reaches above Shasta Lake. With the exception of the Pit River, which has a series of hydroelectric project dams that begin immediately upstream from Shasta Lake, each of these tributaries has more than 30 miles of high-quality, fish-bearing riverine habitat between the Shasta Lake and upstream dams on the Sacramento and McCloud rivers and steep headwater reaches on Squaw Creek.

For the most part, land use along the main Shasta Lake tributaries upstream from the reservoir is a mix of Federal and privately managed forest and

[2] This refers to a stream draining the terrain and entering Shasta Lake northwest of Shasta Dam, a historic mining district; not to be confused with the Squaw Creek drainage forming the "Squaw Creek Arm" of the lake.

timberlands and except for sparse residential development, several small municipalities, and the hydropower projects on the Pit, McCloud, and Sacramento rivers much of the area is lightly developed. The Sacramento River above Shasta Lake is paralleled by a major interstate highway and railroad transportation corridor. In July 1991, a railroad accident spilled 19,000 gallons of the fumigant pesticide metam sodium into the Sacramento River near the town of Dunsmuir, approximately 35 stream miles upstream from Shasta Lake. Metam sodium is highly toxic and killed aquatic and riparian vegetation, aquatic macroinvertebrates, and fish and amphibians along the entire length of the river to Shasta Lake, where a massive chemical containment and neutralization effort was mounted. Ecological recovery efforts were implemented shortly after this spill incident and populations of fish, aquatic macroinvertebrates, and the vegetation adjacent to the stream have attained levels that appear to be in a natural dynamic equilibrium consistent with full recovery, although some amphibian and mollusk population remained depressed at least 15 years later (Cantara Trustee Council 2007).

In addition to the four primary tributaries, there are 1,232 intermittent and perennial stream channels totaling about 2,962 miles of channel that contribute seasonal or year-round flows to Shasta Lake. Most of these channels are relatively short and steep and may be classified as confined headwater channels that contribute water, sediment, and organic and inorganic material to Shasta Lake. Many (64 percent) of these channels are intermittent and have stream slopes greater than 10 percent (mean gradient of 27 percent). Net Trace model results indicate that about 33 percent of these stream channels are perennial. About 20 percent of these channels (716) have gradients less than 10 percent and are likely to support fish and other aquatic organisms. In the Klamath Mountain and Cascade geomorphic provinces, stream channels with gradients up to about 4 percent to 7 percent and possessing sufficient flows typically exhibit a good potential to support habitation by fish and other aquatic organisms although steeper slopes do not necessarily, in and of themselves, preclude habitation by fish, particularly trout, sculpins, and dace (Naiman 1998; Reeves, Bisson, and Dambacher 1998). Of the channels surveyed, about 79 percent of those that appeared to have good fish-bearing potential flow into the Sacramento, Squaw, and Pit Arms of Shasta Lake (see Chapter 4, “Geology, Geomorphology, Minerals, and Soils,” for more detail).

Aquatic habitat for resident and adfluvial fishes is generally limited in intermittent tributaries to Shasta Lake because a large percentage (92 percent) of these channels does not possess suitable hydrologic conditions (i.e., sufficient duration and amount of discharge) and/or are too steep to provide accessible habitat, even seasonally, for fish. The gradient of most of these tributaries rapidly increases upstream from the shoreline, and natural barriers to fish are common. These barriers are most often created by cascades, waterfalls, and steep reaches of stream channel (i.e., greater than 7 percent slope) that are more than one-quarter mile in length. Stream channel data generated from field inventories and analysis using Net Trace based on Reclamation’s geographic information system (GIS) Digital Elevation Model (DEM) indicate that most barriers on the perennial tributaries occur near the reservoir. Fifty-four percent of all of the intermittent and 30 percent of the perennial tributaries surveyed in 2011 and 2012 contained partial or complete barriers to fish migration within the varial zones of the proposed reservoir enlargement. However, the estimated number of these perennial streams with complete passage barriers located between 1,070 feet and 1,090 feet msl is only 15, or 10 percent, of the 154 perennial tributaries to Shasta Lake (see Fisheries and Aquatic Ecosystems Technical Report for details).

The aquatic habitat composition of Shasta Lake's perennial tributaries is more diverse than in intermittent tributaries. Consequently, two percent of intermittent and 87 percent of perennial tributaries to Shasta Lake sampled in 2011 and 2012 were found to be inhabited by fish (see Fisheries and Aquatic Ecosystems Technical Report for details). Only cold-water species (trout) were observed in intermittent streams during periods of surface flow and in isolated pools after cessation of flow. Cold-water species inhabited 83 percent and warm-water species inhabited 48 percent of the sampled perennial tributaries. Warm-water species were mostly confined to portions of tributary channels within that portion of currently inundated areae. In the few perennial tributaries (less than 10 percent) where warm-water species were found upstream from the reservoir in 2012, the streams had low gradient channels (less than or equal to 2 percent) with an abundance of flatwater habitat (see Fisheries and Aquatic Ecosystems Technical Report for details).

The only special-status aquatic vertebrate species observed in some of these tributaries was the foothill yellow-legged frog; no special-status fish (e.g., hardhead) or invertebrate species were detected, although hardhead have previously been detected in some perennial tributaries (i.e., Sacramento and Pit rivers) (see *Fisheries and Aquatic Ecosystems Technical Report* for details).

Upper Sacramento River (Shasta Dam to Red Bluff)

Keswick Reservoir USFWS conducts a propagation and captive broodstock program for endangered winter-run Chinook salmon at the Livingston Stone National Fish Hatchery, located at the base of Shasta Dam on the Sacramento River upstream from Keswick Reservoir. The program consists of collecting adult winter-run Chinook salmon from the mainstem Sacramento River, holding and spawning the adults, rearing the juveniles in the hatchery environment, and then releasing them back into the mainstem Sacramento River downstream from Keswick Dam. The overriding goal of the program is to supplement the endangered population and provide an insurance policy against extinction. The propagation program (initiated in 1989), and the captive broodstock program (initiated in 1991) are recognized in the Recovery Plan for Sacramento River winter-run Chinook salmon (NMFS 2014)). Water is supplied to the hatchery from Shasta Dam.

Keswick Reservoir is operated by Reclamation as a reregulating facility. Water levels in Keswick Reservoir are subject to operational changes at Whiskeytown and Shasta lakes. The reservoir provides habitat for a variety of aquatic organisms, including native and nonnative fish. Table 11-2 includes the fish species known to occur in Keswick Reservoir. The aquatic habitat is mostly riverine in character in the upper reach of Keswick Reservoir and slow current, run-of-the-river habitat in the lower half of the reservoir. In addition to water released from Shasta Dam and Whiskeytown Lake, this reservoir is the recipient of surface flows and sediment from Spring Creek, as well as groundwater, emanating from the Iron Mountain Mine. Additional information on the relationship between Spring Creek and Keswick Reservoir is provided in Chapter 9, "Hazards and Hazardous Materials."

Keswick Dam to Red Bluff The upper Sacramento River (Keswick Dam to Red Bluff) provides vital fish spawning, rearing, and/or migratory habitat for a diverse assemblage of native and nonnative species (Table 11-2).

Native species present in this reach of the river can be separated into anadromous and resident species. Native anadromous species include four runs of Chinook salmon, steelhead, green sturgeon (*Acipenser medirostris*), white sturgeon, and Pacific lamprey. Native resident species include Sacramento pikeminnow, Sacramento splittail, Sacramento sucker, hardhead, California roach (*Lavinia symmetricus*), and rainbow trout.

Nonnative resident species present in the upper Sacramento River include largemouth bass, smallmouth bass, white and black crappie (*Pomoxis annularis* and *P. nigromaculatus*), channel catfish (*Ictalurus punctatus*), white catfish (*Ameiurus catus*), black bullhead (*A. melas*), brown bullhead (*A. nebulosus*), bluegill (*Lepomis macrochirus*), green sunfish (*L. cyanellus*), and golden shiner (*Notemigonus crysaleucas*).

See Table 11-1 for a list of special-status species with the potential to occur in the upper Sacramento River.

Lower Sacramento River and Delta Like habitats in the primary study area, habitats in the extended study area provide vital fish spawning, rearing, and/or migratory habitat for a diverse assemblage of native and nonnative species. Many of those species are the same as those found in the primary study area, including Chinook salmon, steelhead, and sturgeon (see the *Fisheries and Aquatic Ecosystems Technical Report*).

Trinity River The Trinity River provides habitat for Southern Oregon/Northern California Coast Coho salmon (*Oncorhynchus kisutch*), Southern Oregon/Northern California Coast Chinook salmon, Klamath Mountains Province steelhead, green sturgeon, white sturgeon, Pacific lamprey, resident rainbow trout, speckled dace, three-spine stickleback, Klamath small scale sucker (*Catostomus rimiculus*), prickly sculpin, riffle sculpin, brook trout

(*Salvelinus fontinalis*), brown trout, American shad, brown bullhead, golden shiner, and green sunfish. Coho salmon and Klamath Mountains Province steelhead are included in this discussion because they are special-status species, while CVP and SWP operations in response to changes at Shasta Dam have the potential to affect Trinity River flows.

See Table 11-1 for a list of special-status species with the potential to occur in the Trinity River.

CVP/SWP Service Areas

See Table 11-1 for a list of special-status species with the potential to occur in the CVP/SWP Service Areas.

11.1.3 Aquatic Macroinvertebrates

The constant flow of water in river systems provides an energetically convenient and economical way for aquatic macroinvertebrates to disperse to new habitats; this movement downstream is known as drift. Some invertebrates passively enter the drift (e.g., benthic organisms may be entrained in the water column when a large current sweeps through), and others exhibit active drift behavior (individuals actively enter the water column by voluntary actions) (Waters 1965, 1972; Müller 1974; Wiley and Kohler 1984). Macroinvertebrates drift to colonize new habitats (for dispersal of various life stages or to find suitable resources), or leave unsuitable habitats (in response to habitat quality or predation pressure). Drift is one of the most important downstream dispersal mechanisms for macroinvertebrates. Macroinvertebrates drift more commonly in the evening, usually at dusk (Waters 1972, Müller 1974, Wiley and Kohler 1984, Smock 1996).

Drifting invertebrates are the primary source of prey for juvenile fish, including salmonids (Chapman and Bjornn 1969). Juvenile Chinook salmon will often seek refuge in slow-velocity habitats where they can rest and drifting invertebrates will tend to be deposited.

Shasta Lake and Vicinity

Aquatic macroinvertebrates provide an important food base for many fish and wildlife species. Benthic macroinvertebrates (BMI) consist primarily of the larvae and nymphal forms of aquatic insects, mollusks, and worms, and serve as an important element of ecological communities and food chains for aquatic invertebrates, such as fish and amphibians. These organisms possess a wide array of life histories and preferences and tolerance of poor water quality. In general, published information on the taxonomy, distribution, and abundance of macroinvertebrates in the Sacramento River drainage is limited. In Shasta Lake, seasonal fluctuations in phytoplankton biomass regulate the abundance of the zooplankton, which form the base of the food chain for the lake's fisheries. Typically, the spring phytoplankton bloom peaks in late-March and April at the on-set of thermal stratification, when nutrients are abundant in surface waters and available to the algae, and again in the fall coincident with the breakdown of the thermocline and mixing of the water column (Lieberman and Horn 1998). The zooplankton community of Shasta Lake is dominated by cladoceran and copepod species, with lower abundance of several rotifer species. Cladocera are most abundant during algae blooms and their abundance wanes, with a corresponding increase in copepod abundance, during the mid-summer (Lieberman and Horn 1998).

Surveys conducted in 2011 and 2012 in tributaries of Shasta Lake found that BMI communities, with a few exceptions, were generally indicative of good habitat and water quality conditions capable of supporting healthy, functioning, and productive ecosystems. The BMI community was largely dominated by cool/warm (eurythermal) taxa, which is expected as a function of the region's Mediterranean climate; taxa representing both pool and riffle specialists; and taxa representing the collector-filterer and collector-gatherer functional feeding guilds, which is also expected based on the relative position and trophic status of the tributary sampling sites within the watersheds (see *Fisheries and Aquatic Ecosystems Technical Report* for details). Tributaries to the Sacramento River arm exhibited among the highest BMI abundances and taxa richness and diversity, although Pit River arm tributaries also exhibited relatively high taxa diversity. Tributaries in legacy mining districts immediately north of Shasta Dam and in portions of the Squaw Creek arm exhibited very depauperate BMI communities, with a high proportion of taxa tolerant of polluted conditions (see *Fisheries and Aquatic Ecosystems Technical Report* for details).

A number of different aquatic mollusks (e.g., snails, limpets, mussels, and clams) are known to inhabit the principal tributaries and general vicinity of Shasta Lake, including several species of management importance (Frest and Johannes 1995, 1999; Howard 2010). Several species of hydrobiid "spring snails" are known to inhabit the upper reaches of the Sacramento and McCloud rivers upstream from Shasta Lake (Frest and Johannes 1995, 1999) in spring complexes and associated headwater areas. These snails require clear, cold-water streams with cobbly gravel beds and tend to be associated with submergent vegetation; however, none of these species has been reported in the reaches of tributaries near Shasta Lake. A number of these spring snails and other stream-dwelling snails are ecologically important and are managed by the USFS and BLM under guidelines for Survey and Manage Species (see Table 11-1).

The USFS sensitive freshwater mussel, the California floater (*Anodonta californiensis*), is also known historically to have occurred in Shasta Lake tributaries near the head of the lake (Howard 2010; Zustak 2007). However, surveys of historically occupied sites around Shasta Lake failed to find this species (Howard 2010) nor was it detected by casual surveys and benthic sampling of the smaller perennial and intermittent tributaries to Shasta Lake in 2012 (Reclamation 2014). This species has experienced significant population declines throughout its range, primarily because of hydromodification of its habitat (Howard 2010). Its preferred habitat is unpolluted, slow-moving rivers and large streams, with beds composed of balanced mixtures of gravel, sand, and silt; however, California floaters are sometimes found in lake shore areas with stable water levels and suitable water currents and substrates (Pennak 1989). Other freshwater mollusks commonly observed in the tributaries of Shasta Lake include another freshwater mussel of the genus *Gonidea* and freshwater limpets of the genus *Lanx* (Howard 2010). The kneecap lanx (*Lanx Patelloides*) has been recently added to the USFS sensitive species list and is known to occur in the vicinity of the McCloud River Bridge. Another mollusk, Black juga (*Juga nigrina*) was recently added to the USFS sensitive species list. It was not detected during the 2014 field surveys but Shasta Lake and its tributaries are within the known range of this species (Cordeiro and Perez 2011). The western pearlshell (*Margaritifera falcata*) is also historically known from the McCloud River, but its close dependence on migratory salmonids for its life cycle has undoubtedly resulted in a decline in its abundance since construction of Shasta Dam blocked anadromous fish migrations (Howard 2010).

Invasive Species

New Zealand Mudsnail The New Zealand mudsnail (*Potamopyrgus antipodarum*), known to have been introduced to North America since about 1987 (Bowler 1991), was identified in Shasta Lake at the Bridge Bay Marina on September 10, 2007 (Benson and Kipp 2011). New Zealand mudsnail have also been found lower in the Central Valley, including Sacramento River near Red Bluff, and the American, Mokelumne and Calaveras rivers (Benson and Kipp 2011). This invasive aquatic mollusk is known from a number of other locations within California and can reach densities of over 500,000 snails per square meter. Densities can fluctuate seasonally, with lowest densities coinciding with the freezing winter months (Proctor et al. 2007). New Zealand mudsnails are highly effective competitors and predators of many native North American benthic macroinvertebrates, including other mollusks, crustaceans, and important aquatic insects. Predators of the New Zealand mudsnail include rainbow trout, brown trout, sculpins, and mountain whitefish (*Prosopium williamsoni*) (Proctor, Kerans, and Clancey 2007). Unfortunately, snails are capable of passing through the digestive system of fish alive and intact (Bondesen and Kaiser 1949).

Possible pathways of introduction into Shasta Lake include contaminated recreational watercraft and trailers and recreational water users (Proctor, Kerans, and Clancey 2007). Introduced snails may also be transported in the feathers and mud adhering to waterbirds and wildlife as they move from one waterbody to another. Other vectors known to spread the snails, such as contaminated livestock, commercial ships, and dredging/mining equipment, are less likely in the case of Shasta Lake’s invasion given the lack of commercial activities on the lake. If the particular clone detected in Shasta Lake is tolerant of the local conditions, a rapid colonization of the lake and its tributaries could occur through a variety of vectors.

The potential involvement of recreational watercraft and trailers and recreational water users in the translocation of New Zealand mudsnails between State waters is of immediate concern. Enlargement of Shasta Lake could provide a larger perimeter of shoreline accessibility for the snail, but not necessarily increase preferred lake habitats. In lakes in North America, New Zealand mudsnails do not commonly occupy shoreline habitats. Highest densities of New Zealand mudsnails occur at depths of between 20 and 25 meters (m) in Lake Ontario (Proctor, Kerans, and Clancey 2007).

Quagga and Zebra Mussel Quagga mussels (*Dressenia bugensis*) and zebra mussels (*Dressenia polymorpha*), are invasive European aquatic mollusks introduced to North America in ship ballast water and first discovered in Lake Erie in 1989 (Spidle, Marsden, and May 1994), have not been found in Shasta Lake, to date, but were discovered in California at Lake Havasu in 2007 (Cohen 2007). The CDFW has begun monitoring at Lake Shasta for adult mussels and veligers (Baumgartner 2008). Possible pathways of introduction into Shasta Lake include contaminated recreational watercraft and trailers and recreational water users. The potential involvement of recreational watercraft and trailers and recreational water users in the translocation of dressenid mussels between State waters is of immediate concern. Enlargement of Shasta Lake could provide a greater area of deepwater and littoral habitat available for occupation by quagga and zebra mussels.

In a 2007 report produced for CDFW, Cohen (2007) described the temperature, calcium, pH, DO, and salinity tolerances of quagga mussels in an effort to assess the vulnerability of various California waters to invasion by quagga mussels and zebra mussels. Cohen identified calcium thresholds as the most important environmental factor influencing distribution of zebra mussels in North America and applied similar thresholds for quagga mussels. In an investigation of the portion of the Sacramento River watershed including Whiskeytown Reservoir and the watersheds above Shasta Dam, Cohen found that the McCloud River above Shasta Lake and the Pit River near Canby have the proper range of salinity, DO, temperature and calcium (at less than or equal to 12 milligrams per liter to be of low and moderate suitability to invasion by quagga mussels.

Upper Sacramento River (Shasta Dam to Red Bluff)

A large-scale monitoring effort on the Sacramento River from Keswick Dam to Verona, coordinated by DWR in 2001, found that benthic macroinvertebrate diversity and richness decreased as the river moved downstream. Oligochaetes, chironomids, and mollusks became more prominent in this reach than in the reach from Keswick Dam to Red Bluff (Sacramento River Watershed Program 2002).

Petrusso and Hayes (2001) examined the diurnal feeding habits of juvenile Chinook salmon in the Sacramento River between RM 193 and RM 275 (downstream and upstream from Red Bluff, respectively) in relation to drifting invertebrates. Chironomids and baetids dominated both the drift and stomach contents. Diets of 153 juvenile salmonids were examined; more than 63 percent of the diet was made up of chironomids of all life stages. Baetids composed 14 percent of the total diet. It was concluded that based on measurements of mean stomach fullness and availability of drifting organisms, there was reasonable feeding opportunity during the sampling period in spring 1996. Mean drift densities ranged from 211 to 2,100 organisms per 100 cubic meters, with an overall mean of 617 organisms per 100 cubic meters (Petrusso and Hayes 2001). Daily mean drift density appeared to show no spatial patterns across the several sites sampled.

Lower Sacramento River and Delta

Aquatic macroinvertebrates provide an important food base for many fish and wildlife species. In general, published information on the taxonomy, distribution, and abundance of macroinvertebrates in the Sacramento River and Delta are limited.

Current macroinvertebrate monitoring efforts on the Sacramento River have focused on large-basin scale patterns, and survey sites on the mainstem have been at various locations along the study reach. As part of the Sacramento River Watershed Program, CDFW collected snag samples at two sites, one site near Colusa and one site near Hamilton City. Dominant taxa found in the fall of 1999 at the Hamilton City site included Orthocladiinae, Naididae, Ephemeroptera (*Baetis* and *Acentrella* sp.), and Trichoptera (*Hydropsyche* sp.) (Sacramento River Watershed Program 2002). Schaffter, Jones, and Karlton (1983) found no substantial difference in abundance of drifting invertebrates near riprapped and natural habitats on the Sacramento River. More than 50 percent of the drift was composed of chironomids, baetids, and aphids. Analysis of fish diets found the same 3 families in 72 percent of the guts sampled.

As mentioned above under "Upper Sacramento River (Shasta Dam to Red Bluff)," a large-scale monitoring effort by DWR on the river from Keswick Dam to Verona found that benthic macroinvertebrate diversity and richness decreased as the river moved downstream. Oligochaetes, chironomids, and mollusks became more prominent in this reach than in the reach from Keswick Dam to Red Bluff (Sacramento River Watershed Program 2002).

Also, as described previously, Petrusso and Hayes (2001) examined the diurnal feeding habits of juvenile Chinook salmon in the river between River Mile (RM) 193 and RM 275 (downstream and upstream from Red Bluff, respectively) in relation to drifting invertebrates. Petrusso and Hayes found that chironomids and baetids dominated both the drift and stomach contents; they concluded that there was reasonable feeding opportunity during the sampling period and that daily mean drift density appeared to show no spatial patterns.

The lower rivers and Delta support a diverse assemblage of zooplankton and macroinvertebrates. Many of these invertebrates are native to the Bay-Delta while many have been introduced into the estuary through ship ballast water discharges, oyster planting, and other processes. Many of the fish species forage on small zooplankton (e.g., copepods) during their early lifestages or throughout their life, while larger macroinvertebrates such as amphipods, shrimp, and crabs provide a forage source for many of the other fish species. Sturgeon and many of the flatfish, for example, forage extensively on shrimp (e.g., Cangon) while other fish such as largemouth bass forage extensively on crawfish. The macroinvertebrate communities are affected by changes in salinity gradients and other habitat factors as well as by filter feeding by other introduced nonnative species such as the Asian overbite clam that has extensively colonized areas of the estuary such as Suisun Bay.

Macroinvertebrate monitoring in the Delta has been focused on impacts to food web dynamics as a result of increases in phosphorous and nitrogen, and on loss of macroinvertebrate species diversity due to nonnative species introductions. The macroinvertebrate communities of the Delta are characterized by low diversity and are dominated by a minimal number of species (less than 10) (Nichols 1980). This is in part because of the predominately soft, silty substrate found throughout the Delta, and an ever-changing fresh and salt water (brackish) water mix (Nichols 1980).

11.2 Regulatory Framework

Several Federal, State, and local agencies have regulatory authority or responsibility over activities that affect aquatic and fisheries resources. These regulatory authorities are described in the following sections.

11.2.1 Federal

Federal Endangered Species Act

Pursuant to the Federal Endangered Species Act (ESA), USFWS and NMFS have authority over projects that may result in take of a federally listed species or adversely affect its designated critical habitat. Under the ESA, the definition of "take" is to "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." Under Federal regulation, "take" is further defined to include habitat modification or degradation where it would be expected to result in death or injury to listed fish and wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. If the project may affect a federally listed species, either an incidental take permit, under Section 10(a) of the ESA through a Habitat Conservation Plan (HCP), or a Federal interagency consultation, under Section 7 of the ESA, is required. Section 7(a)(2) states that each Federal agency shall, in consultation with the Secretary of the Interior, ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat. In the primary and extended study area, USFWS has regulatory jurisdiction over freshwater and estuarine fishes (such as delta smelt), while NMFS has jurisdiction over anadromous fish species that include Chinook salmon, steelhead, and green sturgeon, as well as marine fish and mammals.

Protection of these listed species is typically addressed through issuance of BOs and incidental take authorization by USFWS and NMFS, as well as designation of critical habitat. BOs have been issued for delta smelt by USFWS (2008) and for winter-run and spring-run Chinook salmon, Central Valley steelhead, and green sturgeon by NMFS (2009). These two most recent BOs were challenged in Federal court and remanded to the agencies for revisions. USFWS and NMFS have requested extensions on the deadlines for completing the revisions to the BOs required by the Federal court rulings.

NMFS Recovery Plan

Under Section 4(f) of the ESA, both NMFS and USFWS are required to publish a recovery plan for each species it lists as threatened or endangered. These plans must have objective and measureable criteria that would help the species be removed from the ESA list, a description of site-specific management actions necessary for the species recovery, and estimates of time and cost to carry out the recommended recovery measures.

In 2014, NMFS published the *Final Recovery Plan for Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and Distinct Population Segments of Central Valley Steelhead* (NMFS 2014). In this Recovery Plan, NMFS indicates that the recovery of winter-run Chinook salmon is affected by the Shasta cold-water pool by stating:

> *"Currently, winter-run Chinook salmon spawning is limited to the mainstem Sacramento River downstream of Shasta and Keswick dams where the naturally-spawning population is artificially maintained by cool water releases from the dams. Within the Sacramento River, the spatial distribution of spawners is largely governed by water year type and the ability of the CVP to manage water temperatures.*
>
> *The fact that this ESU is comprised of a single population with very limited spawning and rearing habitat increases its risk of extinction due to local catastrophe or poor environmental conditions. There are no other natural populations in the ESU to buffer it from natural fluctuations. A single catastrophe with effects persisting for four or more years could result in extinction of the Sacramento River winter-run Chinook salmon ESU (Lindley et al. 2007). Such potential catastrophes include volcanic eruption of Lassen Peak, prolonged drought which*

> *depletes the cold water pool in Shasta Reservoir or some related failure to manage cold water storage, a spill of toxic materials with effects that persist for four years, or a disease outbreak.*
>
> *After two years of drought, Shasta Reservoir storage would be insufficient to provide cold water throughout the winter-run Chinook salmon spawning and embryo incubation season, resulting in partial or complete year class failure. A severe drought lasting more than 3 years would likely result in the extinction of winter-run Chinook salmon. The probability of extended droughts is increasing as the effects of climate change continue (see Chapter 6).”*

While the action plans surrounding this issue of cold-water pool are focused primarily on reintroduction into the upper watershed (upstream from Shasta Dam), these actions for upstream reintroduction may not be achievable. Improving the cold-water pool could reduce impacts to the species recovery if the reintroduction process is not successful. Additionally, NMFS includes management actions to improve gravel augmentation programs downstream from Keswick Dam.

Sustainable Fisheries Act (Essential Fish Habitat)

In response to growing concern about the status of United States fisheries, Congress passed the Sustainable Fisheries Act of 1996 (Public Law 104-297) to amend the Magnuson-Stevens Fishery Conservation and Management Act (Public Law 94-265), the primary law governing marine fisheries management in the Federal waters of the United States. Under the Sustainable Fisheries Act, consultation is required by NMFS on any activity that might adversely affect essential fish habitat. Essential fish habitat includes those habitats that fish rely on throughout their life cycles. It encompasses habitats necessary to allow sufficient production of commercially valuable aquatic species to support a long-term sustainable fishery and contribute to a healthy ecosystem. Fish species managed under Essential Fish Habitat by NMFS within the Bay-Delta include Pacific salmon, starry flounder, and English sole.

Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act requires Federal agencies to consult with USFWS, NMFS, and State fish and wildlife resource agencies before undertaking or approving projects that control or modify surface water. The recommendations made by these agencies must be fully considered in project plans by Federal agencies.

Federal Clean Water Act, Section 404

Section 404 of the Federal Clean Water Act (CWA) requires project proponents to obtain a permit from USACE before performing any activity that involves any discharge of dredged or fill material into “waters of the United States,” including wetlands. Waters of the United States include navigable waters of the United States, interstate waters, all other waters where the use or degradation or destruction of the waters could affect interstate or foreign commerce, tributaries to any of these waters, and wetlands that meet any of these criteria or that are adjacent to any of these waters or their tributaries. Many surface waters and wetlands in California, including those in the primary and extended study area, meet the criteria for waters of the United States.

Federal Clean Water Act, Section 402

CWA Section 402 regulates construction-related stormwater discharges to surface waters through the National Pollutant Discharge Elimination System (NPDES) program, which is administered by the U.S. Environmental Protection Agency (EPA). In California, the State Water Resources Control Board (State Water Board) is authorized by the EPA to oversee the NPDES program through the regional water quality control boards (regional water boards), in this case, the Central Valley Regional Water Quality Control Board (CVRWQCB).

Federal Clean Water Act, Section 401

CWA Section 401(a)(1) specifies that any applicant for a Federal license or permit to conduct any activity that may result in any discharge into navigable waters will provide the Federal licensing or permitting agency with a certification that any such discharge will not violate State water quality standards. The RWQCBs administer the Section 401 program with the intent of prescribing measures for projects that are necessary to avoid, minimize, and mitigate adverse impacts on water quality and ecosystems.

Central Valley Project Improvement Act

Reclamation’s evolving mission was written into law on October 30, 1992, with the passage by Congress and signing by President George H.W. Bush, of Public Law 102-575, the Reclamation Projects Authorization and Adjustment Act of 1992. Included in the law was Title 34, the CVPIA. The CVPIA amended previous authorizations of the CVP to include fish and wildlife protection, restoration, and mitigation as project purposes having equal priority with irrigation and domestic water supply uses, and fish and wildlife enhancement having equal priority with power generation. The following are among the changes mandated by the CVPIA:

- Dedicating 800,000 acre-feet annually to fish, wildlife, and habitat restoration.
- Authorizing water transfers outside the CVP service area.
- Implementing the Anadromous Fish Restoration Program (AFRP).
- Creating a restoration fund financed by water and power users.
- Providing for the Shasta TCD.

- Implementing fish passage measures at RBPP.
- Planning to increase water supplies for CVP deliveries.
- Mandating firm water supplies for Central Valley wildlife refuges.
- Meeting the Federal trust responsibility to protect fishery resources on the Trinity River.

The CVPIA is being implemented on a broad front. The Final Programmatic Environmental Impact Statement for the CVPIA analyzes projected conditions in 2022, 30 years from the CVPIA's adoption in 1992. The Final Programmatic Environmental Impact Statement was released in October 1999, and the CVPIA Record of Decision (ROD) was signed on January 9, 2001.

Operations of the CVP reflect provisions of the CVPIA, particularly Sections 3406(b)(1), (b)(2), and (b)(3). The U.S. Department of the Interior's Decision on Implementation of Section 3406(b)(2) of the CVPIA, October 5, 1999, provides the basis for implementing upstream and Delta actions with CVP delivery capability. The AFRP assumes that Sacramento River water will be acquired under Section 3406(b)(2).

Ecosystem Restoration Program

CDFW, USFWS, and NMFS are the implementing agencies for the Ecosystem Restoration Program (ERP). The ERP is a multi-agency effort to improve the ecological health of the Bay-Delta watershed by restoring and protecting habitats, ecosystem functions, and native species. Since the program's inception, ERP agencies have identified more than 600 programmatic actions and 119 milestones throughout the Bay-Delta watershed. The strategic plan objectives of the ERP include the following:

- Recover endangered and other at-risk species and native biotic communities.
- Rehabilitate ecological processes.
- Maintain or enhance populations of selected species for sustainable commercial or recreational harvest.
- Protect or restore functional habitat types.
- Prevent or reduce harmful impacts from nonnative species.
- Improve or maintain water quality and sediment quality conditions that support healthy ecosystems.

Bay Delta Conservation Plan The State and Federal water agencies are currently developing the Bay Delta Conservation Plan (BDCP). The BDCP consists of conservation measures that include components for water conveyance facilities combined with water conveyance operations; conservation components including land acquisition for major habitat restoration efforts in the Delta; and components related to reducing other stressors on the Bay-Delta ecosystem. The BDCP conservation measures are specific actions that would be implemented to achieve the biological goals and objectives of the proposed plan, and are a component of the BDCP conservation strategy. The conservation measures and effects assessment related to achieving the BDCP's overall planning goals are incorporated by reference into the EIR/EIS, which was publicly released in December 2013. The BDCP conservation strategy consists of multiple components that are designed to collectively achieve the overall BDCP planning goals of ecosystem conservation and water supply reliability. The conservation strategy includes biological goals and objectives; conservation measures; avoidance and minimization measures; and a monitoring, research, and adaptive management program.

Four broad concepts have been studied to address urban water quality, water supply reliability, and environmental concerns in the Delta: physical barriers, hydraulic barriers, through-Delta facilities, and isolated facilities. Several alternative Delta conveyance facilities are being evaluated as part of the plan. Depending on the alternative, the water conveyance facility components would create a new conveyance mechanism to divert water from the north Delta to existing SWP and CVP export facilities in the south Delta, interacting with operational guidelines to achieve the planning goal outlined above.

Operating Agreements and Constraints

Coordinated Operations Agreement With the goal of using coordinated management of surplus flows in the Delta to improve Delta export and conveyance capability, the Coordinated Operations Agreement (COA) received Congressional approval in 1986 and became Public Law 99-546. The COA, as modified by interim agreements, coordinates operations between the CVP and SWP and provides for the equitable sharing of surplus water supply. The COA requires that the CVP and SWP operate in conjunction to meet State objectives for water quality in the Bay-Delta estuary, except as specified. Under this agreement the CVP and SWP can each contract for the purchase of surplus water supplies from the other, potentially increasing the efficiency of water operations.

The COA specifies two basic conditions for operational purposes: balanced conditions and excess conditions. Balanced water conditions occur when releases from upstream reservoirs plus unregulated flow equal the water supply needed to meet Sacramento Valley in-basin uses plus exports. During balanced water conditions, storage releases required to meet the Sacramento in-basin uses are made 75 percent from the CVP and 25 percent from the SWP. If unstored water is available during balanced conditions, this water is allocated 55 percent to the CVP and 45 percent to the SWP. Excess water conditions occur when Delta inflows (combined releases from upstream reservoirs and unregulated flow) are greater than needed to meet in-basin uses plus export. Under this condition, flow through the Delta is adequate to meet all needs and no coordinated operation between the CVP and SWP is required.

Since 1986, the COA principles have been modified to reflect changes in regulatory standards, facilities, and operating conditions. At its inception, the COA water quality standards were those of the 1978 Water Quality Control Plan; these were subsequently modified in the 1991 Water Quality Control Plan. The adoption of the 1995 Bay-Delta Plan by the State Water Board superseded those requirements. Evolution of the CWA over time has also impacted the implementation of the COA.

ESA Consultation on CVP and SWP Long Term Operation In June 2004, Reclamation prepared the 2004 Operations Criteria and Plan (OCAP) to provide a description of facilities and the operating environment of the CVP and SWP. Using operational information presented in the 2004 OCAP, Reclamation and DWR developed the 2004 OCAP Biological Assessment (BA), prepared as part of the consultation process required by Section 7 of the ESA.

Reclamation consulted with NMFS and USFWS on the 2004 OCAP, and the two agencies issued the 2004 NMFS BO (NMFS 2004) and 2005 USFWS BO (USFWS 2005), respectively. In 2007, the District Court for the Eastern District of California (District Court), in *Natural Resources Defense Council v. Kempthorne*, found the 2005 USFWS BO to be unlawful and inadequate. In May 2008, in *Pacific Coast Federation of Fishermen's Associations v. Gutierrez,* the District Court found the 2004 NMFS BO to be unlawful and inadequate. The District Court remanded both BOs to the agencies.

In 2008, Reclamation provided the USFWS and NMFS the *Biological Assessment on the Continued Long-Term Operations of the CVP and SWP* (2008 Long-Term Operation BA). USFWS and NMFS released their BOs in 2008 and 2009, respectively.

In the 2008 USFWS BO, the USFWS concluded that the long-term operations of the CVP and SWP would jeopardize the continued existence of delta smelt and adversely modify its critical habitat. Consequently, the USFWS developed a Reasonable and Prudent Alternative (RPA) to avoid jeopardy.

In the 2009 NMFS BO, NMFS similarly concluded that the long-term operations of the CVP and SWP would jeopardize the continued existence of listed salmonids, steelhead, green sturgeon, and killer whales; it also developed an RPA to avoid jeopardy to the species. The RPA included conditions for revised water operations, habitat restoration and enhancement actions, and fish passage actions. Actions were brought challenging the USFWS and NMFS BOs (2008 and 2009) under ESA and the Administrative Procedure Act (APA), concerning the effects of the CVP and SWP on endangered fish species.

2008 USFWS BO Litigation On December 27, 2010, the District Court entered an "Amended Order on Cross-Motions for Summary Judgment" (Doc. 761), remanding the 2008 USFWS BO to the USFWS without vacatur. On May 4, 2011, the District Court issued an amended Final Judgment, ordering the USFWS to complete a final revised BO by December 1, 2013.

In August 2011, the District Court enjoined implementation of USFWS RPA Component 3 (Action 4), the fall X2 requirements, which require a monthly average position of not greater than 74 km in wet years or 81 km in above normal water years eastward of the Golden Gate Bridge. That injunction is no longer in-effect.

The United States and NRDC appealed the District Court's decision invalidating the 2008 USFWS BO. NRDC also challenged the District Court's finding that Reclamation was required to prepare an EIS on its provisional acceptance of the RPA included in the 2008 USFWS BO. Water user plaintiffs cross-appealed the District Court's opinion. On March 13, 2014, the Ninth Circuit Court of Appeals reversed that part of the District Court's opinion that questioned the validity of the 2008 USFWS BO, but affirmed the District Court's finding that Reclamation violated in NEPA in failing to prepare an EIS on its provisional acceptance of the RPA included in the 2008 USFWS BO.

2009 NMFS BO Litigation In September 2011, the District Court remanded the 2009 BO to NMFS, without vacatur, finding in favor of the Federal government on some counts and in favor of water contractor plaintiffs on other counts. The District Court has ordered NMFS to prepare a draft BO no later than October 1, 2016. To meet that schedule, Reclamation must issue a draft EIS evaluating the environmental impacts associated with implementing the draft NMFS BO by April 1, 2017 (six months after receiving the draft BO), and a final EIS no later than March 28, 2018. Reclamation must prepare an EIS on any RPA included in the draft NMFS BO by February 1, 2018; NMFS must release a final BO by that same date. Reclamation must issue a ROD, deciding whether to accept the RPA or an alternative, by April 29, 2018. The United States has appealed the District Court's decision, and that appeal is still pending in the Ninth Circuit Court of Appeals.

Summary In February 2013, Reclamation requested reinitiation of ESA Section 7 consultation, to which USFWS and NMFS agreed.

Currently, although the Ninth Circuit Court of Appeals upheld the validity of the 2008 USFWS BO, the USFWS is obligated to issue (or reissue) a BO by December 1, 2015. On that same date, Reclamation must issue a Final EIS analyzing the environmental impacts associated with operating the CVP and SWP under the USFWS BO.

On the NMFS side, NMFS must issue a draft BO to Reclamation no later than October 1, 2016. Reclamation must issue a final EIS no later than February 1,

2018. On that same date, February 1, 2018, NMFS must release a final BO. Reclamation has until April 29, 2018 to issue a ROD.

Real-Time Decision-Making to Assist Fishery Management

Reclamation and DWR work closely with USFWS, NMFS, CDFW, and other agencies to coordinate the operation of the CVP and SWP with fishery needs. This coordination is facilitated through several forums, as discussed below.

CALFED Water Operations Management Team The Water Operations Management Team (WOMT) was established to facilitate decision making at the appropriate levels and provide timely support of decisions. This team, which first met in 1999, consists of management-level participants from Reclamation, DWR, USFWS, NMFS, and CDFW. The WOMT meets frequently to provide oversight and decision making that must routinely occur within the CALFED Bay-Delta Program (CALFED) Ops Group process. The WOMT relies heavily on other teams and work groups for recommendations on fishery actions. It also uses the CALFED Ops Group (see below) to communicate with stakeholders about its decisions. Although the goal of the WOMT is to achieve consensus on decisions, the agencies retain their authorized roles and responsibilities.

Delta Operations for Salmonids and Sturgeon Group The Delta Operations for Salmonids and Sturgeon (DOSS) was established from Action IV.5 in the NMFS BO. The responsibilities of DOSS are to provide advice to the WOMT and NMFS on measures to reduce adverse effects from Delta operations of the CVP and the SWP to salmonids and green sturgeon. DOSS coordinates the work of other technical teams to provide expertise on issues pertinent to Delta water quality, hydrology, and environmental parameters. The 2009 NMFS BO states the DOSS will:

1. Provide recommendations for real-time management of operations to WOMT and NMFS, consistent with implementation procedures provided in this RPA;

2. Review annually project operations in the Delta and the collected data from the different ongoing monitoring programs;

3. Track the implementation of Actions IV.1 through IV.4;

4. Evaluate the effectiveness of Actions IV.1 through IV.4 in reducing mortality or impairment of essential behaviors of listed species in the Delta;

5. Oversee implementation of the acoustic tag experiment for San Joaquin fish provided for in Action IV.2.2;

6. Coordinate with the Smelt Working Group to maximize benefits to all listed species; and

7. Coordinate with the other technical teams identified in this RPA to ensure consistent implementation of the RPA.

CALFED Ops Group The CALFED Ops Group consists of participants from Reclamation, DWR, USFWS, NMFS, CDFW, State Water Board, and EPA. The CALFED Ops Group generally meets 11 times a year in a public setting to discuss CVP and SWP operations, CVPIA implementation, and coordination with efforts to protect endangered species. The CALFED Ops Group held its first public meeting in January 1995, and during the next 6 years the group developed and refined its process. The CALFED Ops Group is recognized within D-1641 and elsewhere as a forum where agencies can consult and achieve consensus on coordinating CVP and SWP operations with endangered species, water quality, and CVPIA requirements. Decisions made by the CALFED Ops Group have been incorporated into the Delta standards to protect beneficial uses of water (e.g., export/inflow ratios and some closures of DCC gates).

Several teams were established as part of the Ops Group. These teams are described below.

Operations and Fishery Forum The stakeholder-driven Operations and Fishery Forum disseminates information about recommendations and decisions regarding CVP and SWP operations. Forum members are considered the contact people for their respective agencies or interest groups when the CALFED Ops Group needs to provide information about take of listed species or address other topics or urgent issues. Alternatively, the CALFED Ops Group may direct the Operations and Fishery Forum to recommend operational responses to issues of concern raised by member agencies.

Data Assessment Team The Data Assessment Team consists of technical staff members from the agencies and stakeholders. The team meets frequently during the fall, winter, and spring to review and interpret data relating to fish movement, location, and behavior. Based on its assessments and information about CVP and SWP operations, the Data Assessment Team recommends potential changes in operations to protect fish.

B2 Interagency Team The B2 Interagency Team was established in 1999 and consists of technical staff members from the agencies. The team meets weekly to discuss implementation of Section 3406(b)(2) of the CVPIA, which defines the dedication of CVP water supply for environmental purposes. It communicates with the WOMT to ensure coordination with the other operational programs or resource-related aspects of project operations.

Fisheries Technical Teams Several fisheries-specific teams have been established to provide guidance on resource management issues. These teams are described below.

Interagency Fish Passage Steering Committee The Interagency Fish Passage Steering Committee (IFPSC) was established in 2010 because of the NMFS 2009 BO, and consists of members from Reclamation, NMFS, USFWS, CDFW, DWR, RWQCB, USFS, and academia. The IFPSC's role is to provide insight and technical, management, and policy direction for a Fish Passage Program to evaluate the potential reintroduction of listed fish species upstream from Shasta, Folsom, and New Melones dams. The IFPSC provides a stabilizing influence so organizational concepts and directions are established and maintained with a visionary view, and provides insight on long-term strategies in support of implementation of the fish passage RPA.

The Sacramento River Temperature Task Group The Sacramento River Temperature Task Group (SRTTG) is a multiagency group formed pursuant to State Water Board Water Right Orders 90-5 and 91-1 to help improve and stabilize the Chinook salmon population in the Sacramento River. Reclamation develops temperature operation plans each year for the Shasta and Trinity divisions of the CVP. These plans consider impacts of CVP operations on winter-run and other races of Chinook salmon. The SRTTG meets in the spring to discuss biological and operational information, objectives, and alternative operations plans for temperature control, and then recommends an operations plan for temperature control to the WOMT. Reclamation then submits a report to the State Water Board, generally on or before June 1 each year.

After the operations plan is implemented, the SRTTG may perform additional studies and hold meetings to revise the plan based on updated biological data, reservoir temperature profiles, and operations data. Updated plans may be needed for summer operations to protect winter-run Chinook salmon, or in fall for the fall-run spawning season. If any changes are made to the plan, Reclamation submits a supplemental report to the State Water Board.

Delta Smelt Working Group The Delta Smelt Working Group was established in 1995 to resolve biological and technical issues regarding delta smelt and to develop recommendations for consideration by USFWS. The working group generally acts when Reclamation and DWR seek consultation with USFWS on delta smelt or when unusual salvage of delta smelt occurs. It also has assisted in developing strategies to improve habitat conditions for delta smelt.

The Delta Smelt Working Group employs a delta smelt decision tree when forming recommendations to send to the WOMT. The working group does not decide what actions will be taken and does not supplant the Data Assessment Team, but merely provides additional advice to the WOMT. The group may propose operations modifications that it believes will protect delta smelt, either by reducing take at the export facilities or by preserving smelt habitat. The decision tree is adapted by the working group as new knowledge becomes available.

American River Operations Work Group In 1996, Reclamation established an operational working group for the lower American River, known as the American River Operations Work Group. Although open to anyone, the working group's meetings generally include representatives from several agencies and organizations with ongoing concerns about management of the lower American River: Reclamation, USFWS, NMFS, CDFW, the Sacramento Area Flood Control Agency, the Water Forum, the City of Sacramento, Sacramento County, the Western Area Power Administration, and the Save the American River Association. The American River Operations Work Group convenes at least monthly to provide fishery updates and reports to enable Reclamation to better manage Folsom Reservoir for fish resources in the lower American River.

National Forest Management Act

The National Forest Management Act requires the USFS to prepare a Land and Resource Management Plan (LRMP) for each National Forest. The LRMPs provide the direction to manage the lands and resources that are associated with National Forest System lands managed by the USFS. In addition to the requirement for LRMPs, the National Forest Management Act also has a specific requirement to "provide for a diversity of plant and animal communities" (16 U.S Code 1604(g)(3)(B)) as part of their multiple use mandate. The USFS must maintain "viable populations of existing native and desired nonnative species in the planning area" (36 Code of Federal Regulations 219.19). In its decision making process, the USFS must also consider impacts to management indicator species (assemblages). These are defined as any species or assemblage of plants or animals that has been identified as representative of a larger group of species with special habitat requirements. The Shasta-Trinity and Mendocino National Forest LRMPs are directly applicable to efforts related to the SLWRI.

U.S. Forest Service Sensitive Species

The Sensitive Species program is designed to meet the National Forest Management Act requirement to demonstrate the USFS's commitment to maintaining biodiversity on National Forest System lands. The program is a proactive approach to conserving species to prevent a trend toward listing under the ESA, and to ensure the continued existence of viable, well-distributed populations. A "Sensitive Species" is any species of plant or animal that has been recognized by the Regional Forester to need special management to prevent it from becoming threatened or endangered.

Shasta-Trinity and Mendocino National Forest Land and Resource Management Plans

Both the STNF and Mendocino LRMPs incorporate the applicable elements of what is commonly referred to as the Northwest Forest Plan, a plan for the management of habitat for late-successional and old-growth forest-related species within the range of the northern spotted owl. These LRMPs encompasses all the goals, standards, and guidelines established in the 1994

ROD for the Northwest Forest Plan, as a well as the goals, standards, and guidelines designed to guide the management of these National Forests. As part of the STNF LRMP, the USFS is required to implement any recovery plans established under the ESA Section 7(a)(1). As signed in 1995, the STNF LRMP incorporates the following goals, standards, and guidelines related to aquatic and fisheries resource issues associated with the project site, which were excerpted from the STNF LRMP (USFS 2003).

Biological Diversity

Goals (LRMP, p. 4-4)

- Integrate multiple resource management on a landscape level to provide and maintain diversity and quality of habitats that support viable populations of plants, fish, and wildlife.

Threatened, Endangered, and Sensitive Species (Plants and Animals)

Goals (LRMP, p. 4-5)

- Monitor and protect habitat for Federally listed threatened and endangered and candidate species. Assist in recovery efforts for threatened and endangered species. Cooperate with the State to meet objectives for state listed species.

- Manage habitat for sensitive plants and animals in a manner that will prevent any species from becoming a candidate for threatened and endangered status.

Wildlife

Goals (LRMP, p. 4-6)

- Meet habitat or population objectives established for management indicator species or assemblages.

- Cooperate with Federal, State, and local agencies to maintain or improve wildlife habitat.

- Maintain natural wildlife species diversity by continuing to provide special habitat elements within Forest ecosystems.

Standards and Guidelines (LRMP, pp. 4-29 through 4-30)

- Consider transplants, introductions, or reintroductions of wildlife species only after ecosystem analysis and coordination with other agencies and the public.

- Develop interpretation/view sites for wildlife viewing, photography, and study. Provide pamphlets, slide shows, and other educational material that enhance the watchable wildlife and other interpretive programs.

- Maintain and/or enhance habitat for Federally listed threatened and endangered or USFS sensitive species consistent with individual species recovery plans.

U.S. Forest Service Survey and Manage Species

In 1994, the U.S. Bureau of Land Management and USFS adopted standards and guidelines. The Northwest Forest Plan was designed to address human and environmental needs served by the Federal forests of the western part of the Pacific Northwest and Northern California. The development of the Northwest Forest Plan was triggered in the early 1990s by the listing of the northern spotted owl and marbled murrelet as threatened under the ESA.

To mitigate potential impacts to plant and wildlife species that have the potential to occur within the range of the northern spotted owl, surveys are required for species thought to be rare or whose status is unknown due to a lack of information. These species became known as the Survey and Manage species. The Northwest Forest Plan has gone through several revisions since its implementation in 1994, including the elimination of the Survey and Manage Mitigation Measure Standards and Guidelines in 2004. RODs to modify the Survey and Manage rule were published in 2004 and 2007; however, both of these RODs were set aside by the courts. As a result of a court-mandated settlement agreement in litigation on the 2007 ROD (Conservation Northwest v. Sherman Case No. C08-1067-JCC (W.D. Wash. July 5, 2011)), modifications to the Survey and Manage Standards and Guidelines were again made; however, the 2011 Settlement Agreement was set aside by the Ninth Circuit Court of Appeals in 2013, and the 2001 ROD was reinstated.

Management Guide for the Shasta and Trinity Units of the Whiskeytown-Shasta-Trinity National Recreation Area

The Management Guide for the Shasta and Trinity Units of the Whiskeytown-Shasta-Trinity National Recreation Area contains management strategies intended to achieve or maintain a desired condition. These strategies take into account opportunities, management recommendations for specific projects, and mitigation measures needed to achieve specific goals. The following strategies related to biological resource issues associated with the project were excerpted from the Management Guide (USFS 2003).

Wildlife (Management Guide, pp. IV-19 through IV-20)

- Management activities will assure population viability for all native and non-native desirable species. Management to insure viability will occur within occupied habitat for bald eagle, peregrine falcon, northern spotted owl, northern goshawk, willow flycatcher, northwestern pond turtle, Pacific fisher, Shasta salamander, and candidate species in accordance with species and/or territory management plans, Forest Orders, and appropriate laws and policy.

- Surveys will continue within potential suitable habitats to determine occupancy status for threatened, endangered, sensitive, and candidate species.

- Cooperation will continue with CDFW and the USFWS regarding habitat management of wildlife species inhabiting the National Recreation Area. Consultation with USFWS will continue regarding habitat management for threatened and endangered species.

11.2.2 State

California Endangered Species Act

Pursuant to the California Endangered Species Act (CESA), a permit from CDFW is required for projects that could result in take of a State-listed threatened or endangered species. Under CESA, "take" is defined as an activity that would directly or indirectly kill an individual of a species, but the definition does not include "harming" or "harassing," as the ESA does. As a result, the threshold for take under CESA is higher than under the ESA (e.g., habitat modification is not necessarily considered take under CESA; proposed activities must meet a no-net-loss standard for CESA listed species). Authorization for take of State-listed species can be obtained through a California Fish and Game Code, Section 2080.1, Consistency Determination or Section 2081 Incidental Take Permit.

"Fully Protected" Fish Species

California law (Fish and Game Code, Section 5515) also identifies 10 "fully protected fish" that cannot lawfully be "taken," even with an incidental take permit. None of these species are present in the primary study area.

California Fish and Game Codes

Additional sections of the California Fish and Game Code that are subject to regulation by CDFW include Section 1505 covering spawning areas on state-owned lands; Sections 5930 through 5948 covering dams and obstructions; and Section 7261 recognizing native trout.

Section 1602 handles streambed alteration agreements. All diversions, obstructions, or changes to the natural flow or bed, channel, or bank of any river, stream, or lake in California that supports wildlife resources are subject to regulation by CDFW under Section 1602 of the California Fish and Game Code. Under Section 1602, it is unlawful for any person, governmental agency, or public utility to do the following without first notifying CDFW: substantially divert or obstruct the natural flow of, or substantially change or use any material from the bed, channel, or bank of any river, stream, or lake, or deposit or dispose of debris, waste, or other material containing crumbled, flaked, or ground pavement where it may pass into any river, stream, or lake. A stream is defined as a body of water that flows at least periodically or intermittently through a bed or channel that has banks and supports fish or other aquatic life. This definition includes watercourses with a surface or subsurface flow that supports or has supported riparian vegetation. CDFW's jurisdiction within altered or artificial waterways is based on the value of those waterways to fish and wildlife. A CDFW streambed alteration agreement must be obtained for any project that would result in an impact on a river, stream, or lake.

California Public Resources Code, Sections 5093.50-5093.70

The California Public Resources Code (PRC) Sections 5093.50 – 5093.70 were established through 1972 enactment of the Wild and Scenic Rivers Act, which was subsequently amended on several occasions. The essential policy of the State in regard to the matters addressed by the PRC is expressed in Section 5093.50:

> *5093.50 It is the policy of the State of California that certain rivers which possess extraordinary scenic, recreational, fishery, or wildlife values will be preserved in their free-flowing state, together with their immediate environments, for the benefit and enjoyment of the people of the state. The Legislature declares that such use of these rivers is the highest and most beneficial use and is a reasonable and beneficial use of water within the meaning of Section 2 of Article X of the California Constitution.*

The PRC identifies, classifies, and provides protection for specific rivers or river segments, as approved by the Legislature (much of the text of the PRC is devoted to detailed descriptions of river segment locations). Rivers or river segments that are specifically identified and classified in the PRC comprise the California Wild and Scenic Rivers System. As described in Section 5093.50 of the PRC, rivers or river segments included in the California Wild and Scenic Rivers System must possess "extraordinary scenic, recreational, fishery, or wildlife values"; however, the PRC does not define these "extraordinary values."

Various amendments to the California Wild and Scenic Rivers Act have been passed, modifying the PRC. Rivers or river segments are added to (or, as in a few past cases, removed from) the System by Legislative action. In 1986, Assembly Bill 3101 (Statutes of 1986, Chapter 894) established a study process to help determine eligibility for potential additions to the California Wild and Scenic Rivers System (Section 5093.547 and Section 5093.548). In 1982, the original mandate in the PRC requiring management plans for designated rivers was eliminated; however, the California Resources Agency is required to coordinate activities affecting the California Wild and Scenic Rivers System with other Federal, State, and local agencies (Section 5093.69).

The PRC has also been modified to protect river segments without formally identifying them as part of the California Wild and Scenic Rivers System. Such protective language for the McCloud River was added to the PRC in Section

5093.542, emphasizing protection of the wild trout fishery in the McCloud River.

California Wild Trout Program

The California Wild Trout Program was established by the California Fish and Game Commission in 1971 to protect and enhance high-quality fisheries sustained by wild strains of trout. The primary purpose of the wild trout program is to identify, enhance, and perpetuate natural and attractive trout fisheries where wild strains of trout are given major emphasis, in contrast to the majority of the State's accessible waters that are managed by planting domesticated catchable-sized trout on a "put and take" basis (Rode 1989; Rode and Dean 2004). The Commission adopted a wild trout policy that provides for the designation of "aesthetically pleasing and environmentally productive" streams and lakes to be managed exclusively for wild trout, where the trout populations are managed with appropriate regulations to be "largely unaffected by the angling process."

All designated waters must meet the following policy criteria (Rode 1989, Rode and Dean 2004):

- Be open to public angling
- Be of sufficient size to accommodate a significant number of anglers without overcrowding
- Be able to support, with appropriate angling regulations, wild trout populations of sufficient magnitude to provide satisfactory trout catches in terms of number or size of fish

Designated wild trout waters are required to have a management plan and must be subject to angling restrictions that "emphasize unique values and diversity of opportunity in the geographic area" (Rode 1989, Rode and Dean 2004). Wild trout waters are required to be managed in accordance with the following stipulations:

- Domestic strains of catchable-sized trout will not be planted in designated wild trout waters.
- Hatchery-produced trout of suitable wild and semi-wild strains may be planted in designated waters, but only if necessary to supplement natural trout reproduction.
- Habitat protection is of utmost importance for maintenance of wild trout populations. All necessary actions, consistent with State law, will be taken to prevent adverse impacts by land or water development projects affecting designated wild trout waters.

The California Fish and Game Commission in 1976 designated a 10.5-mile river segment immediately below McCloud Dam for special management and habitat protection under the Commission's wild trout program (Rode 1988).

11.2.3 Regional and Local

County and City Policies and Ordinances

Shasta, Tehama, Glenn, Sutter, Sacramento, and Yolo counties and the cities of Redding, Colusa, and Sacramento have established codes and policies that address protection of natural resources, including fisheries, sensitive species, and aquatic resources, and are applicable to the project.

Shasta County's general plan emphasizes that the maintenance and enhancement of quality fish and wildlife habitat is critical to the recreation and tourism industry, and acknowledges that any adverse and prolonged decline of these resources could result in negative impacts on an otherwise vibrant industry. The general plan identifies efforts to protect and restore these habitats to sustain the long-term viability of the tourism and recreation industry (Shasta County 2004).

The City of Redding's general plan strives to strike a balance between development and conservation by implementing several measures such as creek-corridor protection and habitat protection (City of Redding 2000).

Tehama County's general plan update provides an overarching guide to future development and establishes goals, policies, and implementation measures designed to address potential changes in county land use and development.

Glenn County's general plan provides a comprehensive plan for growth and development in Glenn County through 2027. This plan recognizes that public lands purchased for wildlife preservation generate economic activity as scientists and members of the public come to view and study remnant ecosystems (Glenn County 1993).

The City of Colusa's general plan seeks to promote its natural resources through increased awareness and improved public access (City of Colusa 2007).

Sutter County's general plan contains policies that generally address preservation of aquatic resources.

Sacramento County's general plan contains policies that promote protection of marsh and riparian areas, including specification of setbacks and "no net loss" of riparian woodland or marsh acreage (Sacramento County 1993).

Yolo County's general plan aims to provide an active and productive buffer of farmland and open space separating the San Francisco Bay Area from

Sacramento, and integrating green spaces into its communities (Yolo County 2009).

11.2.4 Federal, State, and Local Programs and Projects

Watershed Conservancies

Several watershed conservancy groups exist within the study area. These include but may not be limited to the Butte Creek, Mill Creek, Deer Creek, and Cottonwood Creek watershed conservancies. Watershed conservancies tend to focus on developing and implementing conservation efforts on watershed lands.

California Bay-Delta Authority

The California Bay-Delta Authority (CBDA) was established as a State agency in 2003 to oversee implementation of CALFED for the 25 Federal and State agencies working cooperatively to improve the quality and reliability of California's water supplies while restoring the Bay-Delta ecosystem. The July 2000 CALFED *Final Programmatic EIS/EIR* (CALFED 2000b) identified and analyzed a range of alternatives to address these needs and included a Multi-Species Conservation Strategy (MSCS) to provide a framework for compliance with ESA, CESA, and Natural Community Conservation Planning Act. The August 2000 CALFED Programmatic ROD identified 12 action plans, including Ecosystem Restoration, Watersheds, and Water Supply Reliability, among others (CALFED 2000c). The CALFED ERP has provided a funding source for projects that include those involving acquisition of lands within the Sacramento River Conservation Area (SRCA), initial baseline monitoring and preliminary restoration planning, and preparation of long-term habitat restoration management and monitoring plans. In 2009, the California Legislature passed sweeping water reform legislation, including the establishment of the Delta Stewardship Council (DSC). The DSC was transferred all the responsibilities, programs, staff and most of the funding from the CBDA, and the CBDA was dissolved. The DSC was also given additional mandates, including the development of a Delta Plan to guide activities and programs of State and local programs in the legal Delta through a consistency determination process. The Delta Plan is currently undergoing the final public review.

Cantara Trustee Council

The Cantara Trustee Council administers a grant program that has provided funding for numerous environmental restoration projects in the primary study area, including programs in the Fall River watershed, Sulphur Creek, the upper Sacramento River, Middle Creek, lower Clear Creek, Battle Creek, Salt Creek, and Olney Creek. The Cantara Trustee Council is a potential local sponsor for future restoration actions in the primary study area. The Cantara Trustee Council includes representatives from CDFW, USFWS, the CVRWQCB, California Sportfishing Protection Alliance, and Shasta Cascade Wonderland Association.

Resource Conservation Districts

There are numerous resource conservation districts (RCD) within the study area. Once known as soil conservation districts, RCDs were established under California law with a primary purpose to implement local conservation measures. Although RCDs are locally governed agencies with locally appointed, independent boards of directors, they often have close ties to county agencies and the U.S. Natural Resources Conservation Service. RCDs are empowered to conserve resources within their districts by implementing projects on public and private lands and to educate landowners and the public about resource conservation. They are often involved in the formation and coordination of watershed working groups and other conservation alliances. Districts in the vicinity of Shasta Lake and the Sacramento River upstream from Shasta Lake include the Western Shasta County RCD and the Tehama County RCD. To the east are the Fall River and Pit River RCDs, and to the west and north are the Trinity County and Shasta Valley RCDs.

Riparian Habitat Joint Venture

The Riparian Habitat Joint Venture (RHJV) was initiated in 1994 and includes signatories from 18 Federal, State, and private agencies. The RHJV promotes conservation and the restoration of riparian habitat to support native bird population through three goals:

- Promote an understanding of the issues affecting riparian habitat through data collection and analysis.
- Double riparian habitat in California by funding and promoting on-the-ground conservation projects.
- Guide land managers and organizations to prioritize conservation actions.

RHJV conservation and action plans are documented in the *Riparian Bird Conservation Plan* (RHJV 2004). The conservation plan targets 14 “indicator” species of riparian-associated birds and provides recommendations for habitat protection, restoration, management, monitoring, and policy. The report notes habitat loss and degradation as one of the most important factors causing the decline of riparian birds in California. The RHJV has participated in monitoring efforts within the Sacramento National Wildlife Refuge Complex and other conservation areas. The RHJV’s conservation plan identifies lower Clear Creek as a prime breeding area for yellow warblers and song sparrows, advocating a continuous riparian corridor along lower Clear Creek. Other recommendations of the conservation plan apply to the North Delta Offstream Storage Investigation study area.

Sacramento River Advisory Council

In 1986, the California Legislature passed Senate Bill 1086, which called for a management plan for the Sacramento River and its tributaries to protect, restore, and enhance fisheries and riparian habitat in an area stretching from the confluence of the Sacramento River with the Feather River and continuing northward to Keswick Dam. The law established an advisory council that included representatives of Federal and State agencies, county supervisors, and representatives of landowners, water contractors, commercial and sport fisheries, and general wildlife and conservation interests. Responsibilities of the advisory council included development of the *Sacramento River Conservation Area Forum Handbook* to guide management of riparian habitat and agricultural uses along the river (Resources Agency 2003). This action also resulted in formation in May 2000 of the SRCA Forum, a nonprofit public-benefit corporation with a board of directors that includes private landowners and public-interest representatives from a seven-county area, an appointee of the California Resources Agency, and ex-officio members from six Federal and State resource agencies. The work of the organization is generally focused on planning actions and river management within the SRCA planning area.

Sacramento River Conservation Area Forum

Senate Bill 1086 called for a management plan for the Sacramento River and its tributaries to protect, restore, and enhance both fisheries and riparian habitat. The SRCA Program has an overall goal of preserving remaining riparian habitat and reestablishing a continuous riparian ecosystem along the Sacramento River between Redding and Chico, and reestablishing riparian vegetation along the river from Chico to Verona. The program is to be accomplished through an incentive-based, voluntary river management plan. The *Upper Sacramento River Fisheries and Riparian Habitat Management Plan* (Resources Agency 1989) identifies specific actions to help restore the Sacramento River fishery and riparian habitat between the Feather River and Keswick Dam. The *Sacramento River Conservation Area Forum Handbook* (Resources Agency 2003) is a guide to implementing the program. The Keswick Dam–Red Bluff portion of the conservation area includes areas within the 100-year floodplain, existing riparian bottomlands, and areas of contiguous valley oak woodland, totaling approximately 22,000 acres. The 1989 fisheries restoration plan recommended several actions specific to the study area:

- Fish passage improvements at the Red Bluff Diversion Dam (completed)
- Modification of the Spring Creek Tunnel intake for temperature control (completed)
- Spawning gravel replacement program (ongoing)
- Development of side-channel spawning areas, such as those at Turtle Bay in Redding (ongoing)
- Structural modifications to the Anderson-Cottonwood Irrigation District Dam to eliminate short-term flow fluctuations (completed)

- Maintaining instream flows through coordinated operation of water facilities (ongoing)
- Improvements at the Coleman National Fish Hatchery (partially completed)
- Measures to reduce acute toxicity caused by acid mine drainage and heavy metals (ongoing)
- Various fisheries improvements on Clear Creek (partially completed)
- Flow increases, fish screens, and revised gravel removal practices on Battle Creek (ongoing)
- Control of gravel mining, improvement of spawning areas, improvement of land management practices in the watershed, and protection and restoration of riparian vegetation along Cottonwood Creek (ongoing)

The Nature Conservancy

The Nature Conservancy (TNC) is a private nonprofit organization involved in environmental restoration and conservation throughout the United States and the world. TNC approaches environmental restoration primarily by strategically acquiring land from willing sellers and obtaining conservation easements. Some of the lands are retained by TNC for active restoration, research, or monitoring activities, while others are turned over to government agencies such as USFWS or CDFW for long-term management. Lower in the Sacramento River basin, TNC has been instrumental in acquiring and restoring lands for the Sacramento River National Wildlife Refuge and managing several properties along the Sacramento River. It also has pursued conservation easements on various properties at tributary confluences, including Cottonwood and Battle creeks.

11.3 Environmental Consequences and Mitigation Measures

11.3.1 Methods and Assumptions

The following sections describe the methods, processes, procedures, and/or assumptions used to formulate and conduct the environmental impact analysis.

This analysis of impacts on fisheries and aquatic ecosystems resulting from implementation of the project alternatives under consideration is based on extensive review of existing documentation that addresses aquatic habitats and fishery resources in the primary and extended study areas, and on water resources modeling analysis.

Summary of Water Resources Modeling

Extensive modeling of hydrologic conditions, water temperature, and salmon production and mortality was performed to provide a quantitative basis from which to assess potential operational effects of the project alternatives on fisheries resources and aquatic habitats within the primary and extended study areas. Model selection and use for each of the variables were as follows:

- **Hydrologic modeling –** CalSim-II (primary and extended study areas)
- **Water temperature modeling –** Sacramento River water temperature model (primary study area)
- **Salmon production and mortality –** SALMOD, Version 3.8 (SALMOD) (primary study area)

Modeling output provided monthly values for each year of the 82-year period of record modeled for river flows, reservoir storage and elevation. These monthly values are then converted to daily values for use in water temperature modeling, which gives 6-hour interval river water temperatures. The period of record is based on records from 1921 through 2003. Outputs on river flow and water temperature were put into weekly form for use in SALMOD to characterize flow- and water temperature–induced production and mortality of salmon under each simulated condition.

The models used in the fisheries analyses (i.e., CalSim-II, Sacramento River water temperature model, and SALMOD) are tools that have been developed for comparative planning purposes, rather than to predict actual river conditions at specific locations and times. The 82-year period of record for CalSim-II and water temperature modeling provides an index of the kinds of changes that would be expected to occur with implementation of a specified set of operational conditions. Output on reservoir storage, river flows, water temperature, and salmon survival for the period modeled should not be interpreted or used as definitive absolutes depicting actual river conditions that would occur in the future. Rather, output for the project alternatives was compared to that for the simulation of the Existing Condition (2005) and No-Action Alternative (future 2030) to determine the following:

- Whether reservoir storage or river flows and water temperatures would be expected to change with implementation of the SLWRI alternatives
- The months in which changes to reservoir storage and river flow and water temperatures could occur
- The relative magnitude of change that could occur during specific months of particular water year types, and whether the relative magnitude anticipated would be expected to result in effects on fisheries resources and aquatic habitats within the region

The models used, though mathematically precise, should be viewed as having reasonable detection limits. Establishing reasonable detection limits is useful when interpreting modeling output for an impact assessment; establishing such limits prevents the user from making inferences beyond the capabilities of the models and beyond the ability to actually measure changes.

The Modeling Appendix provides a more detailed discussion of the modeling process and its application to the project analysis. The appendix describes (1) the primary assumptions and model inputs used to represent hydrologic, regulatory, structural, and operational conditions; and (2) the simulations performed from which effects were estimated. SALMOD is discussed in more detail below.

Modeling Uncertainties and Real-Time Decision-Making As described in Section 11.2, "Regulatory Fraemwork," a process exists to make decisions about CVP and SWP operations in real time. This process allows for fishery management that involves flexible decision-making and adjustments for uncertainties as the outcomes of management actions and other events become better understood.

The modeling simulations conducted to support the analysis of the project alternatives are based on operational assumptions that are generally accepted. However, they do not always capture operational changes that may be associated with the human element of real-time decision-making. Therefore, there may be isolated inaccuracies regarding human decisions made in real time to ensure operational compliance with existing objectives, standards, and/or agreements.

For example, both the NMFS BO for the CVP/SWP long-term operations and various State Water Board orders require that CVP and SWP operations for the Sacramento River meet specific water temperature criteria. In 1997, construction was completed on the TCD at Shasta Dam. The TCD was designed to selectively withdraw water from elevations within Shasta Lake to better manage water temperatures in the upper river, while allowing power generation. The SRTTG is an interagency team that identifies water management alternatives and TCD operations in real time, interprets the availability of cold-water resources in Shasta Lake, and designs an annual/seasonal river temperature compliance strategy, following the guidelines provided in State Water Board Water Right Order 90-5 and multiple BOs.

Reservoir Fisheries Analysis

Monthly values for WSEL, surface area, and cold-water storage in Shasta Lake were calculated for the period from 1921 to 2003 using data outputs from CalSim-II. Values were produced for six alternative dam raise scenarios (project alternatives) using a 2005 water supply demand, and a projected 2030 water supply demand for a total of 12 scenarios. Each year of the hydrologic record was categorized as one of five water year categories (wet, above-normal, below-normal, dry, critical) based on the Sacramento River Inflow Index. Model outputs for the last day of each month from February to July (e.g., February 29, March 31) were used for analysis of potential changes in surface area and WSEL. End-of-month values for April, June, August, and October were used to analyze the potential changes in Shasta Lake's cold-water storage. Potential impacts of the enlargement of Shasta Dam and Shasta Lake on the fisheries resources of Shasta Lake were investigated using several habitat-based metrics that are associated with factors known to limit or otherwise regulate warm-water and cold-water reservoir fish populations. The following metrics were computed and used:

- **Surface Area –** Surface area is the metric used to investigate changes in the amount of available littoral (i.e., shoreline) and limnetic (i.e., open water) habitat, which could impact warm-water and cold-water fisheries, under each of the project alternatives. Variations in surface area influence biological productivity (including fish production) because the upper, lighted layer of the pelagic zone is the principal plankton-producing region of the reservoir. Reservoir enlargement may initially produce a "trophic upsurge" phenomenon that occurs in response to terrestrial habitat inundation, nutrient loading, and increases in labile detritus (Kimmel and Groeger 1986). The initial trophic enrichment will decline and stabilize over time as the reservoir ecosystem approaches its natural trophic equilibrium (Kimmel and Groeger 1986). Trophic depression is a response to decreased nutrient loading and decreased labile detritus. Fisheries production experiences a depression in response to the same factors as well as decreases in available terrestrial organic detritus and loss of cover as inundated vegetation deteriorates (Stables et al. 1990).

- **Cold-Water Storage to Surface Area Ratio –** Cold-water storage to surface area ratio (a dimensionless value) is a useful metric for assessing the potential impact of project alternatives on Shasta Lake's cold-water fishery. Because this ratio relates cold-water volume to the surface area of the reservoir, the metric is sensitive to disproportionate changes in surface area without concomitant changes in the cold-water pool. Stables et al. (1990) suggest that an increase in pelagic and littoral trout habitat accompanied by lake enlargement should lead to higher total fish yield. While increases in water surface area, such as those that might result from reservoir enlargement, can stimulate primary and secondary productivity (Jones and Stokes Associates 1988), access to cold-water refuge can be a limiting factor for cold-water fish production. Therefore, increases in reservoir surface area without proportional increases in cold-water storage are likely to result in little change in cold-water fish production. Conversely, a proportional increase in the cold-water storage to surface area ratio should result in increased cold-water fish productivity.

- **WSEL –** WSEL is a metric that is useful in analyzing the impact of project alternatives on the Shasta Lake warm-water fishery. The timing and duration of WSEL fluctuation can have a great impact on the reproductive success of nearshore spawning fishes (Ploskey 1986). Stable or increasing WSEL during spring months (March through June) can contribute to increased reproductive success, young-of-the-year production, and juvenile growth rate of several warm-water species, including the black basses (Lee 1999, Ploskey 1986). Inundation of shoreline vegetation and structural habitat enhancement features installed around the reservoir also leads to increased structural diversity and availability of spawning substrate and cover for juvenile fishes (Miranda, Shelton, and Bryce 1984, Ratcliff 2006). Conversely, reduced or variable WSEL due to reservoir drawdown during spring spawning months can cause reduced spawning success for warm-water fishes through nest dewatering, egg desiccation, and physical disruption of spawning or nest guarding activities (Lee 1999, Ploskey 1986). Loss of access to inundated shoreline vegetation and habitat enhancement structures during reservoir drawdown in the summer increases predation mortality of juvenile bass and other sport fish (Lee 1999, Ploskey 1986, Ratliff 2006).

WSEL values were obtained from CalSim-II outputs, as described above, and were graphed for each comparison set. Monthly change in surface elevation (monthly change in elevation) was calculated by subtracting the previous month's surface elevation from each month. For example, change in elevation for March was calculated by subtracting the February 29 WSEL from the March 31 WSEL. The relative difference in monthly change in elevation from the basis-of-comparison and the relative percent difference in monthly change in elevation were graphed for each comparison set, with the basis-of-comparison as the Existing Condition in sets one and three, and the No-Action Alternative in set two. The relative difference and relative percent difference in monthly change in elevation between CP3, CP4, and CP4A were also graphed for comparison sets one and three.

Surface area values obtained from CalSim-II outputs were graphed for each comparison set. Relative differences in monthly surface area values from the basis-of-comparison were graphed for each comparison set, as described for WSEL.

Cold-Water Storage Values obtained from CalSim-II outputs were divided by surface area outputs to generate monthly cold-water storage to surface area ratios. The cold-water storage to surface area ratios were graphed for comparison set two only. The relative difference and relative percent difference in monthly cold-water storage to surface area ratio from the basis-of-comparison were also calculated and graphed for comparison set two only.

For each metric, CalSim-II projections for monthly change under the Existing Condition were graphed against the No-Action Alternative.

Additionally, graphs were prepared depicting the expected ratio of monthly cold-water storage to surface area, monthly surface area, and expected monthly changes in elevation under 2005 and 2030 water demands (separately) for all water year types for CP1, CP2, CP3, CP4, CP4A, and CP5 for the Shasta Lake and vicinity portion of the primary study area. For example, in the discussion of potential impacts associated with implementation of CP1 is a graph comparing monthly surface area under CP1 with a 2005 water supply demand to monthly surface area under the Existing Condition, and a separate graph making this comparison for CP1 with a 2030 water supply demand versus the No-Action Alternative.

Values for the three habitat metrics were compared in graphical form to address the following issues:

- How reservoir cold-water storage, WSEL, or the cold-water storage to surface area ratio would be expected to change with implementation of the project alternatives
- Months or seasons when potential changes in the habitat metrics could occur
- Relative magnitude of change that could occur during specific months of particular water year types, and the potential impacts these changes could have on fisheries resources, aquatic resources, and habitats within the reservoir

All analyses were based on CalSim-II model outputs. CalSim-II is California's primary water operations planning model, used by both Reclamation and DWR. While model sensitivity and accuracy calibrations are still being developed for CalSim-II, the model's widespread use for water planning and management operations in Central California makes it useful and its projections easily comparable between projects. However, model outputs should be used as tools for interpretation of anticipated impacts rather than actual projections (Close et al. 2003).

Tributaries to Shasta Lake

The existing data on the aquatic resources occurring in many of the tributaries to Shasta Lake are limited. Early in the SLWRI planning process, 12 representative tributary streams to Shasta Reservoir were selected for focused examination as part of this assessment, including five tributaries to Shasta Lake: Sacramento River, McCloud River, Pit River, Squaw Creek, and Big Backbone Creek. Subsequently, to support ongoing analyses of potential impacts of the proposed enlargement of Shasta Dam and Reservoir, Reclamation, USFS, and CDFW collaboratively developed a study plan to obtain additional data on other important tributary streams. Data were collected by surveying 132 representative tributaries to Shasta Lake between November 2011 and August 2012. The primary objectives of this study were to document:

1. The composition, distribution, and relative abundance of native and nonnative fish species.
2. The condition of aquatic habitat.
3. The condition of benthic macroinvertebrate communities.
4. The occurrence of special-status species.
5. The occurrence of invasive aquatic species.

Chinook Salmon Between Keswick Dam and Red Bluff Pumping Plant

SALMOD is a computer model that simulates the dynamics of freshwater salmonid populations, but for the SLWRI, SALMOD simulates population dynamics for all four runs of Chinook salmon between Keswick Dam and RBPP. SALMOD was applied to this project because:

1. SALMOD had been previously used on the upper Sacramento River (from Keswick Dam to Battle Creek) (Kent 1999, Bartholow 2003). John Bartholow and John Heasley (contractor to the U.S. Geological Survey (USGS)) were instrumental in extending SALMOD to assess fish production and mortality between Keswick Dam and the RBPP. They also assisted in preparation of the SALMOD description included in the Modeling Appendix, Chapter 5, which contains a detailed discussion of the SALMOD model.
2. SALMOD has been updated using model parameters and techniques developed for use on the Klamath River and from Sacramento River-specific Chinook salmon information obtained from USFWS and CDFW fisheries biologists (Bartholow 2003; Modeling Appendix, Chapter 5). The USGS completed a thorough review and update of model parameters and techniques on the Klamath River that enabled a smooth transfer of relevant model parameters to the Sacramento River (Bartholow and Henriksen 2006).
3. Resource agency personnel agreed that using SALMOD was the appropriate means of evaluating potential conditions after being presented with the model's capabilities by John Bartholow (formerly with USGS) under contract by Reclamation.
4. SALMOD was peer reviewed by Lisa Thompson and Chris Mosser of University of California (UC) Davis (Thompson and Mosser 2011).

5. SALMOD was approved for use in several other Federal-level studies, including the Reclamation's 2008 Biological Assessment on the Continued Long-Term Operations of the CVP and SWP for compliance with Section 7 of the ESA (Reclamation 2008) and resulting NMFS 2009 BO (NMFS 2009).

Comprehensive Plans Evaluated SALMOD used weekly streamflow and water temperature to evaluate multiple scenarios: the Existing Condition, No-Action Alternative, CP1, CP2, CP3, CP4, CP4A, and CP5. The Existing Condition is based on a 2005 level of development. The No-Action Alternative represents the Future Conditions (2030) without completion of a project to address the objectives of the SLWRI. CP1 is based on a 6.5-foot dam raise; CP2 is based on a 12.5-foot dam raise; and CP3 is based on an 18.5-foot dam raise. CP4 and CP4A were developed based on an 18.5-foot dam raise with operations modified to create a more "fish-friendly" environment, with a portion of the reservoir storage dedicated to fish, to either improve flows or water temperatures, and adds spawning and rearing habitat restoration. CP5 is based on an 18.5-foot dam raise that adds spawning and habitat restoration.

Additional scenarios were evaluated, but not pursued further, due to inconsistencies or lack of achievement of the primary goals of the project.

In the original presentation (August 16, 2005) of the SALMOD model to resource agency personnel, interest was expressed in setting the number of spawning adults at the AFRP production goal for the Sacramento River upstream from the RBPP (Table 11-3). The AFRP defined natural production to be that portion of Chinook salmon not produced in hatcheries, and defined total production to be the sum of harvest and escapement. The production goals include adult fish removed from the system due to both sport and commercial fishing in both freshwater and marine environments.

SALMOD was also conducted using a spawning population based on the 1999 to 2006 average adult return provided by CDFW (2014), which documents spawning escapement estimates for each year in the Central Valley. Using this average was expected to result in a more realistic effect of the project operations on Chinook salmon under the Existing Condition, and on the premise that the AFRP goals should take the populations closer to a state of carrying capacity. Thus, if a population is already at or nearing carrying capacity, increases in the populations are unlikely. The starting year for calculating the average number of spawners was in 1999 because the effects of the TCD began in 1999.

Populations of 500 or more spawning Chinook salmon are considered necessary for accurate results using SALMOD because it is a deterministic model that relies on the "law of large numbers." When populations are "low" (an arbitrary term), mean responses are quickly affected by environmental stochasticity and individual variability, which are factors SALMOD was not designed to address. Therefore, because the 1999 to 2006 average for spring-run Chinook salmon was 207 adult spawners, the criterion of 500 or more fish was not met. However, because of concerns expressed by CDFW and USFWS, the spawning population was left at 207 fish for purposes of the model.

While steelhead are not evaluated directly in SALMOD, effects for late fall-run Chinook salmon are considered representative for steelhead since NMFS, in their 2009 BO, assumed late fall-run Chinook salmon could be used as a surrogate for steelhead because they have similar life history stages, including spawning at the same time of the year (NMFS 2009).

Production numbers generated by SALMOD are not intended to be used as actual population estimates, but as a basis of comparison between alternatives. There are multiple reasons why the juvenile production results should not be used as strict population estimates, including the fact that each year, the same spawning population is used. That is, any increase or decrease in production at the end of a cohort year is not carried forward into another set of spawners. In other words, SALMOD is not a life-cycle model, and only takes into account the environmental and biological factors that affect survival of Chinook salmon between Keswick Dam and RBPP. Because each alternative starts with the same number of spawners each year, the differences between the effects of alternatives on each run of Chinook salmon become clear and easy to evaluate. Additionally, the use of SALMOD allows the focus of impacts to be where the greatest direct effects of the project occur – that is, the Sacramento River upstream from RBPP.

Table 11-3. Number of Spawning Fish Incorporated into SALMOD Model

Reach	Fall-Run	Late Fall-Run	Winter-Run	Spring-Run
California Department of Fish and Game (Grand Tab, 1999 through 2006 average)				
Keswick to ACID	6,658	4,725	3,591	9
ACID to Highway 44 Bridge	4,011	2,096	1,761	39
Highway 44 Bridge to Airport Road Bridge	7,175	3,123	3,041	66
Airport Road Bridge to Balls Ferry Bridge	12,405	2,507	163	36
Balls Ferry Bridge to Battle Creek	8,337	767	9	22
Battle Creek to Jellys Ferry Bridge	12,146	282	9	31
Jellys Ferry Bridge to Bend Bridge	8,789	130	17	3
Bend Bridge to RBPP Inundation Zone	5,044	67	0	0
Total Adult Spawners	**64,565**	**13,697**	**8,591**	**207**
Potential Eggs	**154,956,000**	**32,872,800**	**12,371,040**	**496,800**

Table 11-3. Number of Spawning Fish Incorporated into SALMOD Model (contd.)

Reach	Fall-Run	Late Fall-Run	Winter-Run	Spring-Run
U.S. Fish and Wildlife Service (AFRP goals)				
Keswick to ACID	10,218	9,761	19,320	1,003
ACID to Highway 44 Bridge	6,174	4,328	9,455	4,235
Highway 44 Bridge to Airport Road Bridge	10,925	6,447	16,358	7,021
Airport Road Bridge to Balls Ferry Bridge	19,022	6,169	886	3,901
Balls Ferry Bridge to Battle Creek	12,731	1,591	66	2,340
Battle Creek to Jellys Ferry Bridge	18,629	597	26	3,343
Jellys Ferry Bridge to Bend Bridge	13,427	278	106	334
Bend Bridge to RBPP Inundation Zone	7,705	146	0	0
Total Adult Spawners	**98,830**	**28,318**	**46,218**	**22,178**
Potential Eggs	**237,200,000**	**67,960,000**	**66,552,000**	**53,220,000**

Notes:

Spawners include 52 percent males and 48 percent females.

Number of eggs for late fall-, fall- and spring-run equals 5,000 eggs per female. Winter-run Chinook salmon were assumed to have a lower fecundity of 3,000 eggs per female.

Key:
ACID = Anderson-Cottonwood Irrigation District
AFRP = Anadromous Fish Restoration Program
RBPP = Red Bluff Pumping Plant

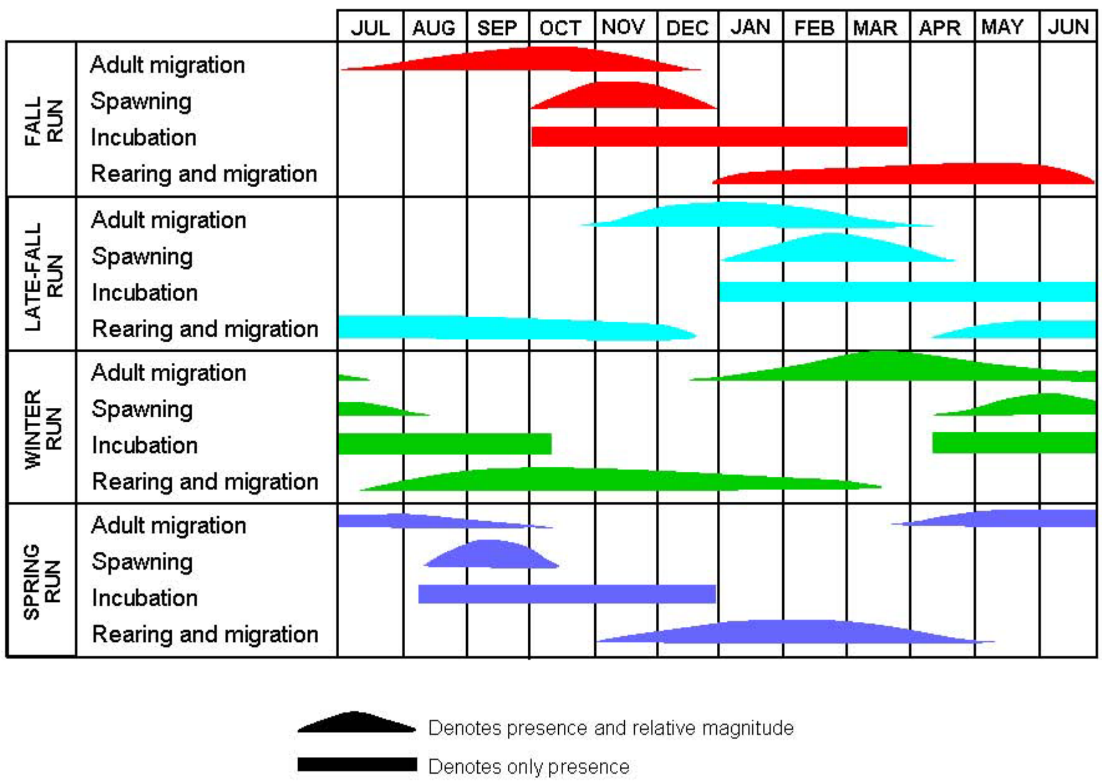
For purposes of evaluating the potential effect of changes in Sacramento River flow and temperature on Chinook Salmon populations between Keswick Dam and Red Bluff Pumping Plant, it was assumed that simulated changes in average annual production that were less than 5 percent (plus or minus) relative to the basis-of-comparison (No-Action Alternative and Existing Conditions) would not be expected to result in a significant (detectable) effect on long term Chinook Salmon production potential. The 5 percent significance threshold was selected to account for the inherent limitations and uncertainties associated with SALMOD, as well as the limitations and uncertainties in the hydrologic model (CalSim-II) and temperature model (Sacramento River water temperature model) used to develop inputs to SALMOD.

SALMOD Output SALMOD produces many forms of output files, but two basic output files – production and mortality (both weekly and annual) – were used in this assessment.

Production derived with SALMOD is the number of immature smolts that survive to pass the RBPP. Because of the uncertainties and limitations inherent in SALMOD, the simulated production should be interpreted as an index which can be used to make relative comparisons between alternatives, and should not be treated as a prediction of absolute numbers of fish production under any alternative.

Two types of mortality were calculated – those caused by the operations (triggered by changes in flow and water temperature) and those that are nonoperations-related (mortalities caused by factors that would still occur without the project in effect, such as disease, predation, and entrainment). Mortality was calculated for each life stage, from migrating/holding adult to the emigrating juvenile.

SALMOD evaluated five separate life stages of Chinook salmon – adult, egg, fry, presmolt, and immature smolt. Figure 11-1 shows the timing for each life stage. Mortality of adults in SALMOD was calculated during the adult migration and spawning time periods. Mortality of eggs (both eggs and in-gravel alevins) was calculated during the adult migration, spawning, and incubation stages, while fry, presmolts, and immature smolts were calculated during the rearing and migration time period.



Source: Vogel and Marine 1991

Figure 11-1. Approximate Timing of the Four Runs of Chinook Salmon in the Sacramento River

Production SALMOD defines production as follows:

Production = (Potential eggs + entrants) – (prespawn egg mortality + other mortality + residuals)

Where:

- Production is the number of young fish surviving to migrate downstream from the RBPP
- Potential eggs are the number of eggs that could be spawned, providing there is no prespawn mortality of either adult females or eggs *in vivo*
- Entrants are the number of young fish entering the project reach (Keswick Dam to RBPP) from the tributaries
- Mortality is the number of eggs and/or fish that die before leaving the project reach
- Residuals are the number of young fish under 60 mm that, after 52 weeks, have not left the project reach

Mortality The mortality process computed all mortality not explicitly included with one of the other processes. This includes mortality from unsuitable water temperature, population density, superimposition, and eggs while *in vivo* and incubating. In addition, a base mortality for all causes not related to any other process (e.g., entrainment, predation) was also computed.

Categories of mortality calculated in SALMOD include the following and are further described in Chapter 5 of the Modeling Appendix:

- **Flow- and Water Temperature-Related Mortality**
  - **Habitat** – Operations-related mortality resulting from forced movement of fry, presmolts, or immature smolts due to habitat constraints.
  - **Temperature** – Operations-related mortality to adults, eggs, fry, presmolts, and/or immature smolts caused by unsuitable water temperatures.
  - **Pre-Spawn** – Includes both lost egg mortality and *in vivo* mortality.
  - **Lost Egg** – Number of eggs lost due to the lack of spawning habitat (a single adult Chinook salmon female cannot spawn because all redds are guarded). It was assumed that these eggs are shed, but as they are alive when leaving the female spawners, they were tallied in the mass balance table. The lack of spawning habitat could be

due to lack of spawning gravel, or lower flows precluding access to suitable spawning habitat.

  - ***In Vivo*** – Number of eggs lost because of operations-related water temperature mortality within the female either before spawning, or prespawning, thermal mortality in which exposure kills the egg or malformed young fish after spawning.
  - **Incubation** – Number of eggs lost if redds (or portions of redds) are affected by changing egg incubation habitat through the duration of the incubation season due to flushing flows scouring out the redds (occurs at a minimum of 60,000 cfs) or redd dewatering from a drop in streamflows resulting from operations-related actions.
  - **Superimposition** – Number of eggs lost due to new spawning on top of a currently incubating redd resulting from operations-related activities.

- **Nonoperations Mortality**
  - **Base** – An accounting of mortality of adults, eggs, fry, presmolts, and immature smolts for everything other than what is in the model, or background mortality (mortality that would occur regardless of the project operations) from factors, such as predation and disease. While these factors may be exacerbated by project operations, they cannot be directly quantified.
  - **Seasonal** – Extra outmigration mortality of presmolts or immature smolts, including diversion-related mortality.

Analysis To evaluate the effects of the project, productions and mortalities were calculated and the differences between the project alternatives and the No-Action Alternative and the Existing Condition were then compared. Most of the years for each run showed minimal differences from the No-Action Alternative, creating an overall average production approaching zero. Each model has its own inherent level of error. In addition, flow data derived from CalSim-II had to be disaggregated from monthly data to weekly, resulting in potential additional error. Because water year type affects Chinook salmon populations, separate production trends based on water year type were evaluated for each run.

Starting populations used in SALMOD were derived from an average population for the years 1999 through 2006, based on the CDFW Grandtab table (CDFW 2014), which lists population estimates on a yearly basis. The AFRP populations were based on the goals identified for the Sacramento River for each run of Chinook salmon.

SALMOD computes mortality by lifestage from various sources, including water temperature and habitat availability. For this evaluation, the lifestage-specific mortalities were converted to smolt equivalent mortality by using annual survival rates for the lifestages later than those at which the mortality occurred. This was an attempt to provide information on the relative effect of water temperature versus habitat availability (as affected by flow volume) on juvenile production. Smolt equivalents were calculated as follows:

Prespawn/Egg Mortality to Immature Smolt Equivalent Prespawn/ Egg Mortality

$$Immature\ Smolt\ Equivalent\ Mortality_i = Mortality_i \times \%\ Survival_{Eggs\ to\ Fry} \times \%\ Survival_{Fry\ to\ Presmolt} \times \%\ Survival_{Preolt\ to\ Immature\ Smolt}$$

Where: $i =$ *Prespawn Base, Prespawn Temperature, Incubation, Superimposition, Eggs-Base, or Eggs-Temperature Mortality*

Fry Mortality to Immature Smolt Equivalent Fry Mortality

$$Immature\ Smolt\ Equivalent\ Mortality_i = Mortality_i \times \%\ Survival_{Fry\ to\ Presmolt} \times \%\ Survival_{Presmolt\ to\ Immature\ Smolt}$$

Where: $i =$ *Base, Temperature, or Habitat Mortality*

Presmolt Mortality to Immature Smolt Presmolt Mortality

$$Immature\ Smolt\ Equivalent\ Mortality_i = Mortality_i \times \%\ Survival_{Pre-Smolt\ to\ Immature\ Smolt}$$

Where: $i =$ *Base, Temperature, Habitat, or Seasonal Mortality*

Although water year classifications are somewhat arbitrary, and the biological year for each run of Chinook salmon encompasses portions of two separate water years, mortalities caused by operations were separated by water year types to identify trends, such as changes in mortality in critical water years due to unsuitable water temperatures. Once the years were separated by water year type, the mortality categories were ranked to determine which mortality category under each alternative was the primary factor affecting production for each run.

The SLWRI has the greatest variations in project operations from the Existing Condition, No-Action Alternative, and the Comprehensive Plans during critical and dry water years (for further detail, refer to the *Hydrology, Hydraulics and Water Management Technical Report*). Besides providing a more reliable water source for delivery, CP1 through CP5 are able to provide more suitable flows and water temperatures during critical and dry water years. This is shown in increased production and/or decreased operations-related mortalities.

The action alternatives are meant to provide the greatest benefits to anadromous fish in critical and dry water years, when anadromous fish are generally at highest risk of flow- and temperature-related mortality. According to NMFS (2009b), Chinook salmon populations, especially winter-run Chinook, are highly vulnerable to global and localized climate changes, including prolonged drought conditions. This is caused by reduced volumes of cold water that can be released from reservoirs, including Shasta Lake, thus affecting spawning and rearing habitat conditions.

Moreover, an evolutionarily significant unit (ESU) that is represented by a single population is vulnerable to the limitation in life history and genetic diversity that would otherwise increase the ability of individuals in the population to withstand environmental variation. Although the status of winter-run Chinook salmon is improving, there is only one population, and it depends on cold water releases from Shasta Dam, which would be vulnerable to a prolonged drought.

The 2009 NMFS BO RPA Action Suite I.2 indicate that the Shasta cold water pool must be managed to maintain suitable water temperatures and habitat for winter-run Chinook salmon downstream from Shasta Dam, particularly in critical water years, extended drought years, and under future conditions, which will be affected by increased downstream water demands and climate change (NMFS 2009). Therefore, critical and dry water years are the most important water year types for the survival of the anadromous fishes, particularly when there is a series of critical and dry water years in succession, because the low storage levels caused by multiple dry years result in warmer waters available for release. These warmer waters increase mortality and reduce production.

Increasing storage, particularly in the cold water pool, and targeting the release of the cold water for critical and dry water years, is expected to improve survival and production of Chinook salmon and steelhead during those periods when they are most vulnerable to temperature- and flow-related mortality. The SLWRI is not intended or expected to significantly increase production during wet, above normal or below normal water year types, because the existing cold water pool is generally sufficient to provide adequate flows and temperatures for Chinook and Steelhead during those years. As a result, the analysis of project impacts on anadromous fish focuses on the impacts in critical and dry years, in addition to considering the average impact for all years combined. In the simulated 81 years modeled in CalSim-II, 13 years were identified as critical water years, and 17 were identified as dry water years.

Riverine Fisheries

Riverine fish, including steelhead and green sturgeon, were evaluated based on differences between monthly mean flows at various modeling locations on the lower Sacramento River and tributaries under each Comprehensive Plan and the monthly mean flows simulated for Existing Conditions and No-Action Alternative conditions. Modeling for the lower American River occurred at Verona and Freeport; for the lower Feather River, modeling occurred below Thermalito Afterbay; and American River modeling occurred near the H Street Bridge in Sacramento. Modeling also occurred on the Trinity River. Additionally, flow changes were used to evaluate the potential change in ecologically important geomorphic processes such as channel forming and maintenance, meander migration, and the creation of seasonally inundated floodplains.

Changes in river flow for each alternative, relative to the basis-of-comparison, were used to reflect and evaluate potential impacts to juvenile salmonid rearing habitat that could result from altered flow regimes. For purposes of evaluating the potential effects of changes in flows on fish habitat, and considering the accuracy and inherent noise within the hydrologic model, it was assumed that changes in the average monthly flows less than 5 percent (plus or minus) relative to the basis-of-comparison would not be expected to result in a significant (i.e., detectable) effect on habitat quality or availability.

Delta Fisheries

Delta Outflow Water development has changed the volume and timing of freshwater flows through the Bay-Delta. Over the past several decades, the volume of the Bay-Delta's freshwater supply has been reduced by upstream diversions, in-Delta use, and Delta exports. As a result, the proportion of Delta outflow depleted by upstream and Delta diversions has grown substantially. In wet years, diversions reduce outflow by 10 percent to 30 percent. In dry years, diversions may reduce outflow by more than 50 percent.

Water development has also altered the seasonal timing of flows passing into and through the Bay-Delta. Flows have decreased in April, May, and June and have increased slightly during the summer and fall (State Water Board 2012). Seasonal flows influence the transport of eggs and young organisms (e.g., zooplankton, fish eggs, larvae) through the Delta and into San Francisco Bay. Flows during the months of February through June play an especially important role in determining the reproductive success and survival of many estuarine species, including salmon, striped bass, American shad, delta smelt, longfin smelt, splittail, and others (Stevens and Miller 1983, Stevens et al. 1985, Herbold 1994, Meng and Moyle 1995, Rosenfield 2010, Rosenfield and Baxter 2007).

For purposes of evaluating the potential effect of changes in outflow on fish habitat within the Bay-Delta, and considering the accuracy and inherent noise within the hydrologic model, it was assumed that changes in the average monthly flows that were less than 5 percent (plus or minus) relative to the basis-of-comparison would not be expected to result in a significant (detectable) effect on habitat quality or availability. It would also not be expected to result in a significant effect on the transport mechanisms provided by Delta outflow, on resident or migratory fish or the zooplankton and phytoplankton on which they rely for a food resource.

Delta Inflow Changes in upstream reservoir storage have the potential to affect Delta inflow (water entering the Delta). Delta inflow may affect hydrologic conditions within Delta channels, hydraulic residence times, salinity gradients, and the transport and movement of various life stages of fish, invertebrates, phytoplankton, and nutrients into and through the Delta. Delta inflow serves as a surrogate metric for a variety of habitat conditions within the Delta that directly or indirectly affects fish and other aquatic resources.

The comparison includes the estimated average monthly inflow under the basis-of-comparison conditions (Existing Condition and No-Active Alternative), the average monthly flow under each of the project alternatives evaluated, and the percentage change between base flows and operations. For purposes of evaluating the potential effect of changes in Delta inflow on fish habitat within the Bay-Delta, and considering the accuracy and inherent noise within the hydrologic model, it was assumed that changes in the average monthly flows that were less than 5 percent (plus or minus) relative to the basis-of-comparison would not be expected to result in a significant (detectable) effect on habitat quality or availability, or the transport mechanisms provided by Delta inflow, on resident or migratory fish or the zooplankton and phytoplankton that they rely on for a food resource.

Sacramento River Inflow Flow within the Sacramento River has been identified as an important factor affecting the survival of emigrating juvenile Chinook salmon, important to the downstream transport of planktonic fish eggs and larvae such as delta smelt and longfin smelt, striped bass, and shad, and important for seasonal floodplain inundation that has been identified as important habitat for successful spawning and larval rearing by species such as Sacramento splittail and as seasonal foraging habitat for juvenile Chinook salmon and steelhead. Sacramento River flows are also important in the transport of organic material and nutrients from the upper regions of the watershed downstream into the Delta. A reduction in Sacramento River flow as a result of SLWRI alternative operations, depending on the season and magnitude of change, could adversely affect habitat conditions for both resident and migratory fish species. An increase in river flow is generally considered to be beneficial for aquatic resources within the normal range of typical project operations and flood control. Very large changes in river flow could also affect sediment erosion, scour, deposition, suspended and bedload transport, and other geomorphic processes within the river and watershed.

For purposes of evaluating the potential effect of changes in Sacramento River inflow on fish habitat within the Bay-Delta, and considering the accuracy and inherent noise within the hydrologic model, it was assumed that changes in the average monthly flows less than 5 percent (plus or minus) relative to the basis-of-comparison would not be expected to result in a significant (detectable) effect on habitat quality or availability, or the transport mechanisms provided by Sacramento River inflow, on resident or migratory fish or the zooplankton and phytoplankton that they rely on for a food resource.

San Joaquin River Flow at Vernalis Flow within the San Joaquin River has been identified as an important factor affecting the survival of juvenile Chinook salmon migrating downstream from the tributaries through the mainstem San Joaquin River and Delta, important to the downstream transport of planktonic fish eggs and larvae such as striped bass, and important for seasonal floodplain inundation that is considered to be important habitat for successful spawning and larval rearing by species such as Sacramento splittail and as seasonal foraging habitat for juvenile Chinook salmon. San Joaquin River flows are also important in the transport of organic material and nutrients from the upper regions of the watershed downstream into the Delta. A reduction in San Joaquin River flow as a result of SLWRI alternative operations, depending on the season and magnitude of change, could adversely affect habitat conditions for both resident and migratory fish species. An increase in river flow is generally considered to be beneficial for aquatic resources within the normal range of typical project operations and flood control. Very large changes in river flow could also affect sediment erosion, scour, deposition, suspended and bedload transport, and other geomorphic processes within the river and watershed.

For purposes of evaluating the potential effect of changes in San Joaquin River flow at Vernalis on fish habitat within the Bay-Delta, and considering the accuracy and inherent noise within the hydrologic model, less than a 5-percent change (plus or minus) relative to the basis-of-comparison, would not be expected to result in a significant (detectable) effect on habitat quality or availability, or the transport mechanisms provided by San Joaquin River flow at Vernalis, on resident or migratory fish or the zooplankton and phytoplankton that they rely on for a food resource.

Low Salinity Zone and X2 In many segments of the Bay-Delta, but particularly in Suisun Bay and the Delta, salinity is controlled by the balance of saltwater intrusion from San Francisco Bay and freshwater flow from the tributaries to the Delta. By altering the timing and volume of flows, water development has affected salinity patterns in the Delta and in parts of San Francisco Bay (Kimmerer 2002, Kimmerer 2004, State Water Board 2012). Under natural conditions, the Carquinez Strait/Suisun Bay region marked the approximate boundary between saltwater and freshwater in the Bay-Delta during much of the year. In the late summer and fall of drier years, when Delta outflow was minimal, seawater moved into the Delta from San Francisco Bay. Beginning in the 1920s, following several dry years and because of increased upstream storage and diversions, salinity intrusions became more frequent and extensive.

Since the 1940s, releases of freshwater from upstream storage facilities have increased Delta outflows during summer and fall. These flows have correspondingly limited the extent of salinity intrusion into the Delta. Reservoir releases have helped to ensure that the salinity of water diverted from the Delta is acceptable during the summer and late fall for farming, municipal, and industrial uses (State Water Board 2012).

Salinity is an important habitat factor in the Bay-Delta (Baxter et al. 1999). All estuarine species are assumed to have optimal salinity ranges, and their survival may be affected by the amount of habitat available within the species' optimal salinity range. Because the salinity field in the Bay-Delta is largely controlled by freshwater outflows, the level of outflow may determine the surface area of optimal salinity habitat that is available to the species (Unger 1994, Kimmerer 2002).

The transition area between saline waters within the Bay and freshwater within the rivers, frequently referred to as the LSZ, is located within Suisun Bay and the western Delta. The LSZ has also been associated with the region of the Bay-Delta characterized by higher levels of particulates, higher abundances of several types of organisms, and a turbidity maximum. It is commonly associated with the position of the 2 parts per thousand salinity isohaline (X2), but actually occurs over a broader range of salinities (Kimmerer 1992, Kimmerer 2004). Originally, the primary mechanism responsible for this region was thought to be gravitational circulation, a circulation pattern formed when freshwater flows seaward over a dense, landward-flowing marine tidal current. However, studies have shown that gravitational circulation does not occur in the LSZ in all years, nor is it always associated with X2 (Burau et al. 1998). Lateral circulation within the Bay-Delta or chemical flocculation may play a role in the formation of turbidity maximum within the estuary.

As a consequence of higher levels of particulates, the LSZ may be biologically significant to some species. Mixing and circulation in this zone concentrates plankton and other organic material, thus increasing food biomass and production. Larval fish such as striped bass, delta smelt, and longfin smelt may benefit from enhanced food resources. Since about 1987, however, introduced species have cropped much of the primary production in the Bay-Delta and there has been virtually no enhancement of phytoplankton production or biomass in the LSZ (CUWA 1994, Lund et al. 2012).

This region continues to have relatively high levels of invertebrates and larval fish, even though the base of the food chain may not have been enhanced in the LSZ during the past decade. Vertical migration of these organisms through the water column at different parts of the tidal cycle has been proposed as a possible mechanism to maintain high abundance in this region, but evidence suggests that vertical migration does not provide a complete explanation (Kimmerer et al. 2002).

Although evidence indicates that X2 and the LSZ are not as closely related as previously believed (Burau et al. 1998), X2 continues to be used as an index of the location of the LSZ and area/or of increased biological productivity. Historically, X2 has varied between San Pablo Bay (River Kilometer 50) during high Delta outflow and Rio Vista (River Kilometer 100) during low Delta outflow. X2 has typically been located between approximately Honker Bay and Sherman Island (River Kilometer 70 to 85). X2 is controlled directly by the volume of Delta outflow, although changes in X2 lag behind changes in outflow. Minor modifications in outflow do not greatly alter X2.

Operations of upstream storage reservoirs have the potential to affect the location of X2 as a result of changes in freshwater flows from the upstream tributaries through the Delta. For purposes of evaluating changes in habitat quantity and quality for estuarine species, a significance criterion of an upstream change in X2 location within 1 kilometer (km) of the basis-of-comparison condition was considered to be less than significant. The criterion was applied to a comparison of hydrologic model results for basis-of-comparison conditions and project alternatives, by month and water year, for the months from February through May and September through November.

Old and Middle River Reverse Flows Reverse flows occur when Delta exports and agricultural demands exceed San Joaquin River inflow plus Sacramento River inflow through the DCC, Georgiana Slough, and Threemile Slough. The capacities of the DCC, Georgiana Slough, and Threemile Slough are fixed; therefore, if pumping rates exceed that total capacity, plus flows in Old River and Eastside streams, the pumping causes Sacramento River water to flow around the west end of Sherman Island and then eastward up the San Joaquin River. This condition occurs frequently during dry years with low Delta inflows and high levels of export at the CVP and SWP pumps. The reverse flow condition within the lower San Joaquin River is typically referred to as Qwest. As second reverse flow condition occurs within Old and Middle rivers as the rate of water diverted at the CVP and SWP export facilities exceeds tidal and downstream flows within the central region of the Delta.

Reverse flows in Old and Middle rivers, resulting from low San Joaquin River inflows and increased exports to the CVP and SWP, have been identified as a potential cause of increased delta smelt and salmonid mortality at the CVP and SWP fish facilities within recent years (Simi and Ruhl 2005, USFWS 2008, NMFS 2009, Wanger 2007). Results of analyses of the relationship between the magnitude of reverse flows in Old and Middle rivers and salvage of adult delta smelt in the late winter shows a substantial increase in salvage as reverse flows exceed approximately -5,000 cfs. Concerns regarding reverse flows in Old and Middle rivers have also focused on planktonic egg and larval stages of delta and longfin smelt, striped bass, splittail, and on Chinook salmon smolts, and while these species do not spawn to a significant extent in the south Delta, eggs and larvae may be transported into the area by reverse flows in Old and Middle rivers. As discussed previously, these early life stages are generally entrained, since they are too small to be effectively screened from export waters.

Old and Middle river reverse flows have been calculated for project alternatives that equate San Joaquin River flow at Vernalis and exports to Old and Middle river flows. Summaries of Old and Middle river reverse flows are included for the Existing Condition, No-Action and action alternatives, by month and water year type. The most biologically sensitive period when the potential effects of reverse flows could affect delta smelt, Chinook salmon, and many other species extends from the late winter through early summer. For purposes of these analyses, a comparison of reverse flows within Old and Middle rivers under the basis-of-comparison and proposed alternative project operations was prepared for the seasonal period extending from January through June. Per the RPAs in the USFWS 2008 and NMFS 2009 BOs, any reduction in Old and Middle River reverse flows (i.e., flows that are more negative) that result in flows greater than (i.e., flows that are more negative) -5,000 cfs are considered to be a significant impact. Additionally, a 5 percent reduction in Old and Middle River flows making them more negative is also considered a significant impact.

CVP and SWP Export Operations Increased exports could increase the risk of entrainment and salvage of resident and migratory fish present in the south Delta, which may include delta smelt, longfin smelt, juvenile Chinook salmon, steelhead, striped bass, and other species of fish as well as macroinvertebrates and nutrients. Increased exports during drier water years in the summer could result in an increased risk of entrainment and salvage for juvenile delta smelt and salmon (April to June) and resident warm-water fish such as striped bass, threadfin shad, catfish, and others during the warmer summer months (July through August). Increased exports could also increase the entrainment and removal of phytoplankton, zooplankton, macroinvertebrates, organic material, and nutrients from the Delta.

Estimated Fish Entrainment/Losses Changes in the volume of water exported at the CVP and SWP facilities is assumed to result in a direct proportional increase or decrease in the risk of fish being entrained and salvaged at the facilities. Using information from the hydrodynamic operations model, in combination with information on the densities of various fish species observed at the salvage facilities, an index in the form of a change in the numbers of a fish species theoretically affected by a change in export operations can be developed. Fish lost to entrainment/salvage at the CVP and SWP were estimated based on monthly estimated combined exports. The project alternatives were modeled in CalSim and assume, for each alternative, that the project would be implemented under the Existing Condition, and under the Future Condition. Both the Existing Condition, or “existing base” conditions, and future base conditions, or “future No-Action Alternative” conditions – which assumes no project was implemented, were assessed.

Data sources used to calculate fish losses at the CVP and SWP consisted of 1995 through 2005 monthly average density data, collected by DWR (2006) at the Skinner Fish Facility and by Reclamation at the Jones Fish Facility located at each export facility, respectively. These density data were calculated for delta smelt, longfin smelt, Chinook salmon, steelhead, striped bass, and splittail. Green sturgeon were considered for this analysis; however, they are seldom collected at the fish facilities, and thus, have not been modeled in the entrainment loss estimates. Fish density data was combined with CalSim results export flows modeled.

From CalSim modeling results, average monthly exports, and average exports each year from 1922 to 2003 in cfs were converted to acre-feet per each month (January through December), and were then multiplied by monthly average densities (number of fish per acre-foot), for each of the selected fish species. Average monthly fish losses calculated for each year were then averaged by water year type (e.g., wet, above-normal, normal, below-normal, dry, and critical) for each month, as well as an average across all years (all water year types), for each month. Fish losses, for each species, were totaled across months to show the total fish loss index for a given species for an average year (all water year types), wet, above-normal, normal, below-normal, dry, and critical years.

Fish losses resulting from entrainment were calculated two ways, which both produced identical entrainment indices to represent the change in entrainment based on changes in CVP and SWP exports as a result of the SLWRI alternatives:

- Fish losses were estimated by calculating losses under the base conditions, and then by calculating losses under the project alternative, from CalSim modeling. The total number of fish lost under the base case was subtracted from the number lost under the project alternative, indicating whether a net benefit (negative number) or a net loss (positive number) would result from the project alternatives.

- Fish losses were estimated by calculating losses directly from the "Alt minus Base" modeling results in CalSim.

The general calculation of the change in entrainment/salvage risk is shown below:

A = Density of fish per acre-foot for a given fish species (e.g., delta smelt, longfin smelt, salmon, striped bass, steelhead, splittail)

B = Monthly export rate (cfs), by year

C = [*B* x 1.983 x (number of days/month)] = average monthly exports (for CVP+SWP) for a given year, 1922 to 2003, in acre-feet

D = [A] [C] = Average monthly fish loss, per species, in a given year

D_A = $\sum$ ($C_{1922,}$ C_{1923} … C_{2003}) = Average monthly fish losses at the CVP + SWP

D_W = $\sum$ (*wet water years*) = Fish losses, by month, at the CVP + SWP, based on wet water years, 1922 to 2003

D_{AN} = $\sum$ (*above-normal water years*) = Fish losses, by month, at the CVP + SWP, based on above-normal water years, 1922 to 2003

D_N = $\sum$ (*normal water years*) = Fish losses, by month, at the CVP + SWP, based on normal water years, 1922 to 2003

D_{BN} = $\sum$ (*below-normal water years*)) = Fish losses, by month, at the CVP + SWP, based on below-normal water years, 1922 to 2003

D_D = $\sum$ (*dry water years*) = Fish losses, by month, at the CVP + SWP, based on dry water years, 1922 to 2003

D_C = $\sum$ (*critical water years*) = Fish losses, by month, at the CVP + SWP, based on critical water years, 1922 to 2003

E_A = ($D_{A\text{-}JANUARY}$ +$D_{A\text{-}FEBRUARY...}$+ $D_{A\text{-}DECEMBER}$) = Total yearly average fish losses, based on monthly average 1922 to 2003 fish losses

E_W = ($D_{W\text{-}JANUARY}$ +$D_{W\text{-}FEBRUARY...}$+ $D_{W\text{-}DECEMBER}$) = Total yearly fish losses in a wet year, based on monthly average 1922 to 2003 fish losses

E_{AN} = ($D_{AN\text{-}JANUARY}$ +$D_{AN\text{-}FEBRUARY...}$+ $D_{AN\text{-}DECEMBER}$) = Total yearly fish losses in an above-normal year, based on monthly average 1922 to 2003 fish losses

E_N = ($D_{N\text{-}JANUARY}$ +$D_{N\text{-}FEBRUARY...}$+ $D_{N\text{-}DECEMBER}$) = Total yearly fish losses in a normal year, based on monthly average 1922 to 2003 fish losses

E_{BN} = ($D_{BN\text{-}JANUARY}$ +$D_{BN\text{-}FEBRUARY...}$+ $D_{BN\text{-}DECEMBER}$) = Total yearly fish losses in a below-normal year, based on monthly average 1922 to 2003 fish losses

E_D = ($D_{D\text{-}JANUARY}$ +$D_{D\text{-}FEBRUARY...}$+ $D_{D\text{-}DECEMBER}$) = Total yearly fish losses in a dry year, based on monthly average 1922 to 2003 fish losses

$E_C = (D_{C\text{-}JANUARY} + D_{C\text{-}FEBRUARY} \ldots + D_{C\text{-}DECEMBER})$ = Total yearly fish losses in a critical year, based on monthly average 1922 to 2003 fish losses

Impact Mechanisms

The project could potentially affect fisheries and aquatic ecosystems through the following impact mechanisms:

- Construction-related impacts:
  - Temporary construction-related loss or degradation of aquatic habitat
- Operations-related impacts, including the following:
  - Flow- and/or water temperature–related impacts on species of primary management concern
  - Geomorphic impacts resulting from reduced frequency, duration, and/or magnitude of ecologically important intermediate and peak flows
- Delta flow-related effects, including the following:
  - Delta outflow and inflow related effects on species of primary management concern
  - Effects related to changes in Sacramento River inflow to the Delta
  - San Joaquin River flow-related effects
  - Effects on species of primary management concern resulting from changes in the location of the LSZ and X2
  - Effects resulting from reverse flows in Old and Middle rivers
  - Effects of changes in CVP and SWP exports to fish entrainment and salvage

The analysis assessed potential effects on fish species of primary management concern and important aquatic ecological processes from construction activities and/or operations occurring in the primary study area or the extended study area. Species of primary management concern are special-status, ecologically important, and recreationally or commercially important fish species. For the upper Sacramento River (Shasta Dam to Red Bluff) portion of the primary study area, fish species of primary management concern consist of the following:

- Four runs of Chinook salmon (winter-, spring-, fall-, and late fall-run)

- Steelhead
- Green sturgeon
- Sacramento splittail
- American shad
- Striped bass

For the lower Sacramento River to the Delta portion of the extended study area, fish species of primary management concern include the same fish identified above, as well as delta smelt and longfin smelt, and exclude American shad.

For the Trinity River portion of the extended study area, fish species of primary management concern consist of the following:

- Chinook salmon
- Steelhead
- Coho salmon
- Green sturgeon
- White sturgeon

The analysis of potential impacts on primary fish species of management concern considered species' life history stages (adult migration, spawning, egg incubation, and juvenile rearing and emigration) and biological requirements. For all fish species of primary management concern in the Sacramento River, evaluation of potential impacts on individual life stages was based on life history descriptions provided in the *Fisheries and Aquatic Ecosystems Technical Report*.

Increased water supplies or increased supply reliability also could reduce a limitation on population growth, changes in local land use, or on other activities that could affect aquatic habitats and fishery resources in the primary and extended study areas, resulting in potentially significant impacts. The impacts of this growth would be analyzed in general plan EIRs and in project-level CEQA compliance documents for the local jurisdictions in which the growth would occur. Mitigation of these impacts would be the responsibility of these local jurisdictions, and not of Reclamation. The expected increase in water supply deliveries relative to the entire CVP and SWP service areas would be small, however. Assuming increased deliveries could be provided to any number of geographic areas within the CVP and SWP service areas, the project's impact on growth that could affect aquatic habitats would be minor.

Similarly, projects potentially affecting most aquatic habitats and listed species would require permits from CDFW, USACE, USFWS, and NMFS. It is anticipated that effects on aquatic habitats and listed species would be avoided, minimized, and/or mitigated during those agency consultations.

The extent, location, and timing of induced growth are currently highly uncertain; the effects of this growth would be analyzed and mitigated during future land use planning and environmental review for specific projects. Therefore, growth-inducing effects on aquatic habitats and fisheries resources are not discussed further in this chapter.

11.3.2 Criteria for Determining Significance of Effects

An environmental document prepared to comply with NEPA must consider the context and intensity of the environmental effects that would be caused by, or result from, the proposed action. Under NEPA, the significance of an effect is used solely to determine whether an EIS must be prepared. An environmental document prepared to comply with CEQA must identify the potentially significant environmental effects of a proposed project. A "[s]ignificant effect of the environment" means a substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by the project (CEQA Section 15382). CEQA also requires that the environmental document propose feasible measures to avoid or substantially reduce significant environmental effects (CEQA Section 15126.4(a)).

Significance criteria (sometimes called "thresholds of significance") used in this analysis are based on the checklist presented in Appendix G of CEQA; factual or scientific information and data; and regulatory standards of Federal, State, and local agencies. These thresholds also encompass the factors taken into account under NEPA to determine the significance of an action in terms of the context and the intensity of its effects.

For the assessment of impacts on fisheries and aquatic ecosystems, habitat indicators for project operations such as water temperature, flows, and important ecological processes have been used to evaluate whether the project alternatives would have an adverse effect on the species and/or species' habitat. For example, exceedence of monthly mean water temperatures identified by NMFS for certain species (e.g., 56ºF at Bend Bridge from April 15 through September 30 for winter-run Chinook salmon) is one such impact on a habitat indicator. Reduction of reservoir WSELs can reduce the availability of nearshore littoral habitat used by warm-water fish for spawning and rearing, thereby reducing spawning and rearing success and subsequent year class strength; therefore, reservoir WSEL is another habitat indicator used. Changes in river flows and water temperatures during certain periods of the year have the potential to affect spawning, fry emergence, and juvenile emigration. Therefore, changes in monthly mean river flows and water temperatures during certain times of the year (during spawning, incubation, and initial rearing) have also been used as habitat impact indicators for species of primary management concern.

The following significance criteria were developed based on guidance provided by CEQA, and consider the context and intensity of the environmental effects as required under NEPA. Impacts of an alternative on fisheries and aquatic ecosystems would be significant if project implementation would do any of the following:

- Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations or by CDFW, USFWS, or NMFS.
- Conflict with the provisions of an adopted HCP, natural community conservation plan, or other approved local, regional, or State HCP or policies or ordinances protecting biological resources.
- Interfere substantially with the movement of any native resident or migratory fish species or with established habitat, or impede the use of native fish nursery/rearing sites.
- Conflict with a local policy or ordinance that protects aquatic and fishery resources.
- Substantially reduce the habitat of a fish species, cause a fish species to drop below self-sustaining levels, threaten to eliminate a fish or macroinvertebrate community, or substantially reduce the number or restrict the range of an endangered, rare, or threatened fish species.

Significance statements are relative to both the Existing Condition (2005) and Future Conditions (2030), unless stated otherwise.

11.3.3 Direct and Indirect Effects

This section identifies how aquatic habitats and fish communities could be affected by the project. The project could affect fisheries and aquatic ecosystems through the following:

- Causing construction-related loss or degradation of aquatic habitat in the vicinity of and downstream from Shasta Dam.
- Altering flow regimes and water temperatures downstream from Shasta Dam and downstream from other reservoirs with altered releases.

- Causing a reduction in ecologically important geomorphic processes resulting from reduced frequency and magnitude of intermediate to high flows.

By altering reservoir storage and releases, the project would change flow regimes in downstream waterways. In turn, these alterations to the flow regime could affect fishery resources and important ecological processes on which the fish community depends, particularly their instream and seasonal floodplain habitats along waterways immediately downstream from reservoirs.

No-Action Alternative

Under the No-Action Alternative, the Federal Government would take reasonably foreseeable actions, including actions with current authorization, secured funding for design and construction, and environmental permitting and compliance activities that are substantially complete. However, the Federal Government would not take additional actions toward implementing a plan to raise Shasta Dam to help increase anadromous fish survival in the Sacramento River between Shasta Dam and Red Bluff, nor help address the growing water reliability issues in California. Shasta Dam would not be modified, and the CVP would continue operating similar to the Existing Condition. Changes in regulatory conditions and water supply demands would result in differences in flows on the Sacramento River and at the Delta between existing and future conditions. Possible changes include the following:

- Firm Level 2 Federal refuge deliveries
- SWP deliveries based on full Table A amounts
- Full implementation of the Grassland Bypass Project
- Implementation of salinity management actions similar to the Vernalis Adaptive Management Plan
- Implementation of the South Bay Aqueduct Improvement and Enlargement Project
- Increased San Joaquin River diversions for water users in the Stockton metropolitan area associated with the Delta Water Supply Project
- Increased Sacramento River diversions by Freeport Regional Water Project agencies
- San Joaquin River Restoration Program Full Restoration Flows

This alternative is used as a basis of comparison for future condition comparisons.

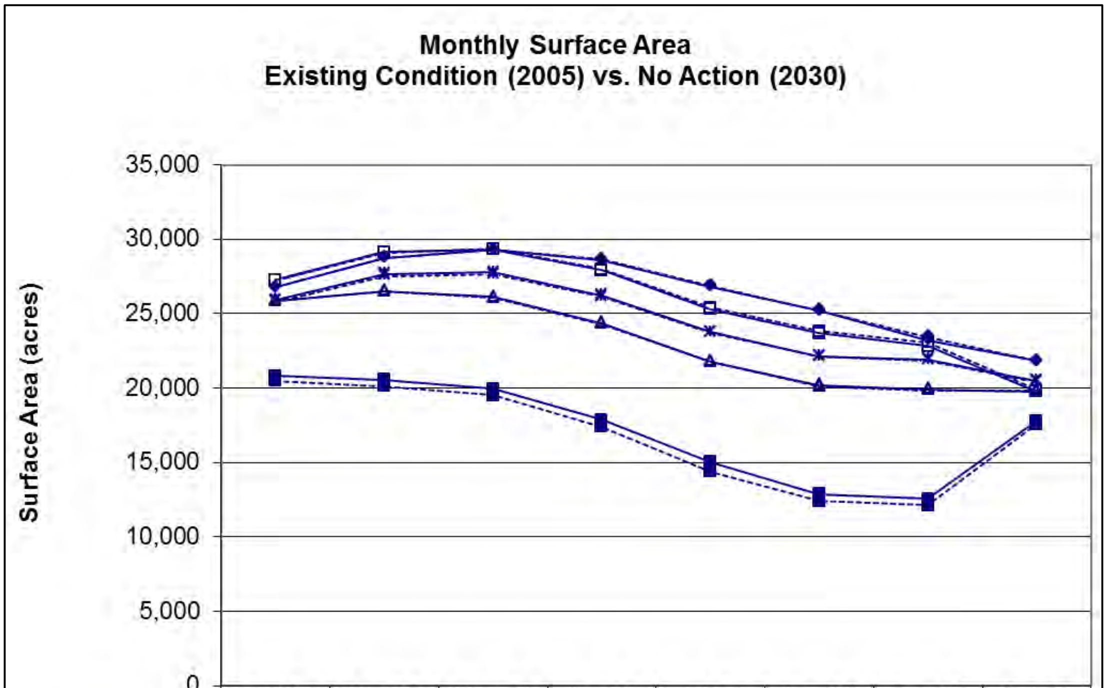
Shasta Lake and Vicinity

Impact Aqua-1 (No-Action): Effects on Nearshore, Warm-Water Habitat in Shasta Lake from Project Operations Under the No-Action Alternative, dam enlargement activities would not be implemented. Seasonal fluctuations in the surface area and WSEL of Shasta Lake could be affected, however, by changing water supply demand and regulatory conditions, which could in turn affect the amount of nearshore, warm-water habitat in Shasta Lake. Such fluctuations could have an adverse effect on the quality and quantity of nearshore, warm-water habitat in the lake.

Under the No-Action Alternative with a 2030 water supply demand, the mean surface area of Shasta Lake in all months and all water year types, except critical years, would be slightly less than under the Existing Condition. The greatest potential decreases would be experienced from September through November in above-normal water years (Figure 11-2). Fluctuations in WSELs are similar for the No-Action Alternative and the Existing Condition and differ by no more than ± 1-foot in any month under all hydrologic conditions (Figure 11-3). Therefore, this impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Seasonal fluctuations in the surface area and WSEL of Shasta Lake could be affected by changing water supply demand and regulatory conditions. Such fluctuations could have an adverse effect on the quality and quantity of nearshore, warm-water habitat in the lake. Therefore, this impact would be potentially significant. Mitigation is not required for the No-Action Alternative.

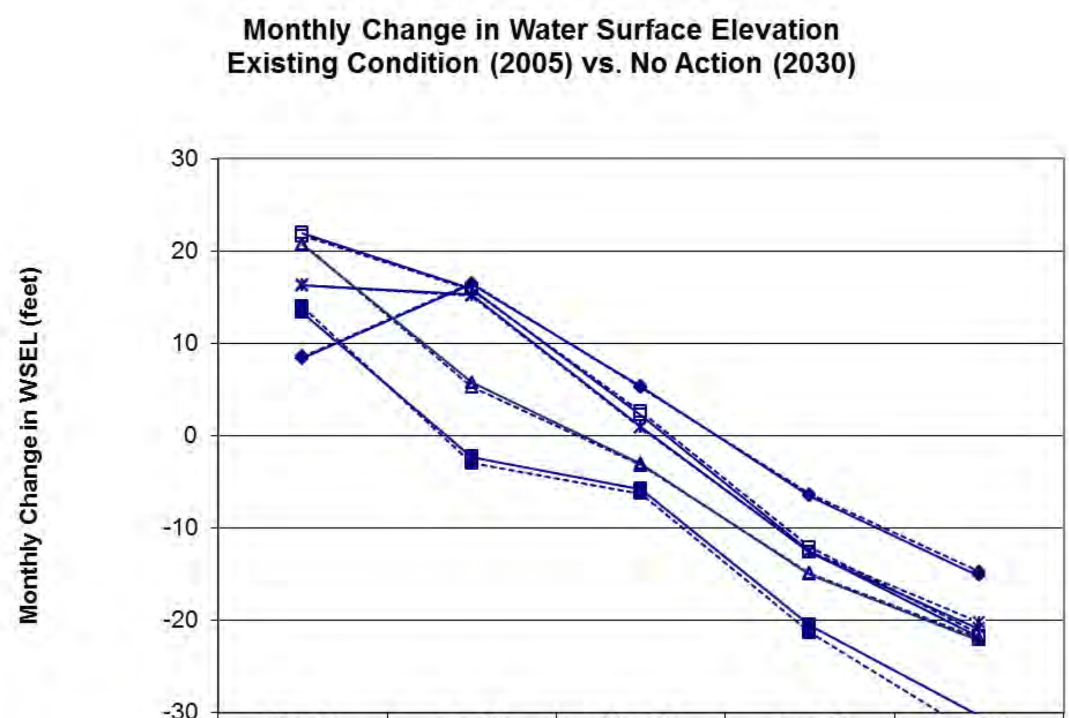
Impact Aqua-2 (No-Action): Effects on Nearshore, Warm-Water Habitat in Shasta Lake from Project Construction Under the No-Action Alternative, dam enlargement activities would not be implemented and no new facilities would be constructed within the vicinity of Shasta Lake. There would be no impact. Mitigation is not required for the No-Action Alternative.



	Mar 31	Apr 30	May 31	Jun 30	Jul 31	Aug 31	Sep 30	Oct 31
EC W	26,790	28,748	29,277	28,624	26,872	25,226	23,413	21,827
EC AN	27,245	29,082	29,336	27,992	25,400	23,826	23,061	19,906
EC BN	25,807	27,534	27,621	26,104	23,714	22,114	21,837	20,425
EC D	25,850	26,467	26,058	24,300	21,754	20,093	19,840	19,828
EC C	20,467	20,142	19,500	17,381	14,400	12,418	12,111	17,572
NA W	26,775	28,735	29,273	28,604	26,797	25,183	23,205	21,808
NA AN	27,258	29,117	29,325	27,921	25,294	23,687	22,800	19,759
NA BN	25,918	27,662	27,770	26,239	23,764	22,137	21,923	20,469
NA D	25,843	26,514	26,134	24,346	21,780	20,209	19,910	19,728
NA C	20,801	20,548	19,942	17,866	15,026	12,873	12,556	17,800

Key:
AN = above-normal water
BN= below-normal water years
C = critical water years
CP = Comprehensive Plan
D = dry water years
EC = Existing Condition
NA = No-Action
W = wet water years

Figure 11-2. Average Monthly Surface Area (in acres) for Each Water Year Type Within the Shasta Lake Vicinity of the Primary Study Area, the Existing Condition Versus No-Action Alternative



	Mar 31	Apr 30	May 31	Jun 30	Jul 31
EC W	9	16	5	-6	-15
EC AN	22	16	3	-12	-21
EC BN	16	15	1	-13	-20
EC D	21	5	-3	-15	-22
EC C	14	-3	-6	-21	-32
NA W	8	16	5	-7	-15
NA AN	22	16	2	-13	-22
NA BN	16	15	1	-13	-21
NA D	21	6	-3	-15	-22
NA C	13	-2	-6	-21	-30

Key: AN = above-normal water
BN= below-normal water years
C = critical water years
CP = Comprehensive Plan
D = dry water years
EC = Existing Condition
NA = No-Action
W = wet water years
WSEL = water surface elevation

Figure 11-3. Average Monthly Change in WSEL (in feet) for Each Water Year Type Within the Shasta Lake Vicinity of the Primary Study Area, the Existing Condition Versus No-Action Alternative

Impact Aqua-3 (No-Action): Effects on Cold-Water Habitat in Shasta Lake
Under the No-Action Alternative, dam enlargement activities would not be implemented. Under this alternative, seasonal fluctuations in the ratio of the volume of cold-water storage in Shasta Lake to the surface area of the lake could be affected by changing water supply demand and regulatory conditions, which could affect the amount of cold-water habitat, including habitat for cold-water fishes, such as resident trout and stocked salmon. This impact would be potentially significant. Mitigation is not required for the No-Action Alternative.

Impact Aqua-4 (No-Action): Effects on Special-Status Aquatic Mollusks Under the No-Action Alternative, dam enlargement activities would not be implemented. Seasonal fluctuations in the surface area and WSEL of Shasta Lake in response to water demand and regulatory conditions could affect special-status aquatic mollusks that may occupy habitat in or near Shasta Lake and its tributaries. These impacts would continue to occur under this alternative. This impact would be less than significant.

One special-status mollusk, the California floater, is known to have historically occurred in tributaries near the head of Shasta Lake. However, surveys of historically occupied sites around Shasta Lake failed to find this species (Howard 2010), and it was not detected during reconnaissance-level surveys of the smaller perennial and intermittent tributaries to Shasta Lake in 2012 (Reclamation 2014). Nine other special-status mollusks could occupy seeps, springs, or tributaries surrounding the reservoir. However, evidence from field surveys of the lower reaches of representative tributaries to the lake did not detect any special-status mollusks (see the *Fisheries and Aquatic Ecosystems Technical Report* for details).

Except for the California floater, the probability of occurrence of other special-status mollusks in Shasta Lake and the lower reaches of its tributaries is low. The California floater is a bivalve that resides in soft sediment on stream and lake beds and, therefore, could be adversely affected by seasonal fluctuations in the WSEL of the lake that currently exists. This impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Impact Aqua-5 (No-Action): Effects on Special-Status Fish Species Under the No-Action Alternative, dam enlargement activities would not be implemented. However, one fish species occurring within the primary study area and designated as sensitive by the USFS, the hardhead minnow, could be affected by seasonal fluctuations in the surface area and WSEL of Shasta Lake in response to changing water demand and regulatory conditions; however, this impact would be less than significant.

Two other USFS sensitive species, rough sculpin (in the Pit River) and redband trout (*Oncorhynchus mykiss stonei*) (in the upper McCloud River), are known to occur upstream from Shasta Lake, but their presence have not been documented in Shasta Lake or in their respective tributaries within the primary study area. The analysis of the No-Action Alternative therefore excludes consideration of these two special-status species.

Fluctuations in the surface area and WSEL of Shasta Lake under the No-Action Alternative could interfere with the connectivity to riverine habitat preferred by hardhead in tributaries that drain into Shasta Lake. However, access to riverine habitat among all the main tributaries to the reservoir would not likely become any more limiting than under current conditions. Therefore, this impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Impact Aqua-6 (No-Action): Creation or Removal of Barriers to Fish Between Tributaries and Shasta Lake Under the No-Action Alternative, dam enlargement activities would not be implemented, and tributaries to Shasta Lake would continue to respond to fluctuations in reservoir levels. New barriers would not be created or removed that could impede or facilitate the movement of native and nonnative fish species between Shasta Lake and its tributaries. There would be no impact. Mitigation is not required for the No-Action Alternative.

Impact Aqua-7 (No-Action): Effects on Spawning and Rearing Habitat of Adfluvial Salmonids in Low-Gradient Tributaries to Shasta Lake Under the No-Action Alternative, dam enlargement activities would not be implemented, and there would be no change to spawning and rearing habitat for adfluvial salmonids in low-gradient tributaries to Shasta Lake. There would be no impact. Mitigation is not required for the No-Action Alternative.

Impact Aqua-8 (No-Action): Effects on Aquatic Connectivity in Non-Fish-Bearing Tributaries to Shasta Lake Under the No-Action Alternative, dam enlargement activities would not be implemented. Therefore, aquatic connectivity in non-fish-bearing streams would not be affected. There would be no impact. Mitigation is not required for the No-Action Alternative.

Impact Aqua-9 (No-Action): Effects on Water Quality at Livingston Stone Hatchery Under the No-Action Alternative, dam enlargement activities would not be implemented. Therefore, there would be no changes to the water system that supplies high-quality water to the Livingston Stone Hatchery. There would be no impact. Mitigation is not required for the No-Action Alternative.

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact Aqua-10 (No-Action): Loss or Degradation of Aquatic Habitat in the Upper Sacramento River During Construction Activities Under the No-Action Alternative, there would be no construction-related loss or degradation of aquatic habitat. No project-generated variation in the storage levels of CVP and SWP reservoirs along the upper Sacramento River or tributaries would occur. If none of the project alternatives were implemented, actions to protect fisheries and aquatic resources would likely continue under existing regulatory requirements. Such actions would include other restoration/management actions intended to protect and enhance fisheries resources. Therefore, no impact would occur. Mitigation is not required for the No-Action Alternative.

Impact Aqua-11 (No-Action): Release and Exposure of Contaminants in the Upper Sacramento River During Construction Activities Under the No-Action Alternative, no project construction–related contaminant exposure in the upper

Sacramento River or tributaries would occur. If none of the project alternatives were implemented, actions to protect fisheries and aquatic resources would likely continue under existing regulatory requirements. Such actions would include other restoration/management actions intended to protect and enhance fisheries resources. Therefore, no impact would occur. Mitigation is not required for the No-Action Alternative.

Impact Aqua-12 (No-Action): Changes in Flow and Water Temperature in the Upper Sacramento River Resulting from Project Operation – Chinook Salmon and Steelhead Flow releases would continue to be operated in compliance with existing BOs and regulatory and contractual requirements, which represent the regulatory baseline. However, it is anticipated that climate change would result in an increase in water temperatures in the upper Sacramento River (NMFS 2009, 2014), which could make it more difficult, especially in critical water years, to meet the water temperature requirements needs for all runs of Chinook salmon, particularly winter-run and spring-run Chinook salmon, as well as steelhead. As a result, the impact to Chinook salmon and steelhead in the upper Sacramento River would be potentially significant. Mitigation is not required for the No-Action Alternative.

Impact Aqua-13 (No-Action): Changes in Flow and Water Temperature in the Upper Sacramento River Resulting from Project Operation – Steelhead, Green Sturgeon, Sacramento Splittail, American Shad, and Striped Bass Flow releases would continue to be operated in compliance with existing BOs and other regulatory and contractual requirements, which represent the regulatory baseline. However, climate change would likely result in an increase in water temperatures (NMFS 2009, 2014). This could make it much more difficult, especially in critical water years, to meet the water temperature requirements for steelhead, green sturgeon, Sacramento splittail, American shad, and striped bass. As a result, this impact would be potentially significant. Mitigation is not required for the No-Action Alternative.

Impact Aqua-14 (No-Action): Reduction in Ecologically Important Geomorphic Processes in the Upper Sacramento River Resulting from Reduced Frequency and Magnitude of Intermediate to High Flows Under the No-Action Alternative, no change to the ongoing geomorphic processes in the upper Sacramento River would occur. No impact would occur. Mitigation is not required for the No-Action Alternative.

Lower Sacramento River, Tributaries, Delta and Trinity River Under the No-Action Alternative, no project-related alteration of CVP and SWP reservoir storage levels, river flows, or water temperatures would occur in the lower Sacramento River, tributaries, and Delta. If none of the project alternatives were implemented, actions to protect fisheries and benefit aquatic environments would likely continue under existing regulatory requirements. Such actions would include other restoration/management actions intended to protect and enhance fisheries resources. Compliance with existing BOs would result in continued pumping curtailments, particularly in dry years. Reclamation and DWR would continue to attempt to reoperate the CVP and SWP, respectively, to avoid decreased deliveries to export users. Therefore, no change in impacts on fisheries and aquatic ecosystems in the lower Sacramento River, tributaries, and Delta would occur under the No-Action Alternative.

Under the No-Action Alternative, no project-related alteration of CVP and SWP reservoir storage levels, river flows, or water temperatures would occur in the Trinity River. Therefore, no change in impacts on aquatic resources in the Trinity River would occur under the No-Action Alternative.

CVP/SWP Service Areas Under the No-Action Alternative, there would be no project-related change in CVP and SWP operations or deliveries to the CVP and SWP service areas. It is anticipated that if the project alternatives were not implemented, actions to protect fisheries and benefit aquatic environments would continue under existing regulatory requirements, including other restoration/management actions and existing BOs intended to protect and enhance fisheries resources.

CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

CP1 focuses on increasing water supply reliability and increasing anadromous fish survival. This plan primarily consists of raising Shasta Dam by 6.5 feet, which, in combination with spillway modifications, would increase the height of the reservoir's full pool by 8.5 feet and enlarge the total storage capacity in the reservoir by 256,000 acre-feet. The existing TCD would also be extended to achieve efficient use of the expanded cold-water pool. Shasta Dam operational guidelines would continue essentially unchanged, except during dry years and critical years, when 70,000 acre-feet and 35,000 acre-feet, respectively, of the increased storage capacity in Shasta Reservoir would be reserved to specifically focus on increasing municipal and industrial (M&I) deliveries. CP1 would help reduce future water shortages through increasing drought year and average year water supply reliability for agricultural and M&I deliveries. In addition, the increased depth and volume of the cold-water pool in Shasta Reservoir would contribute to improving seasonal water temperatures for anadromous fish in the upper Sacramento River.

Shasta Lake and Vicinity

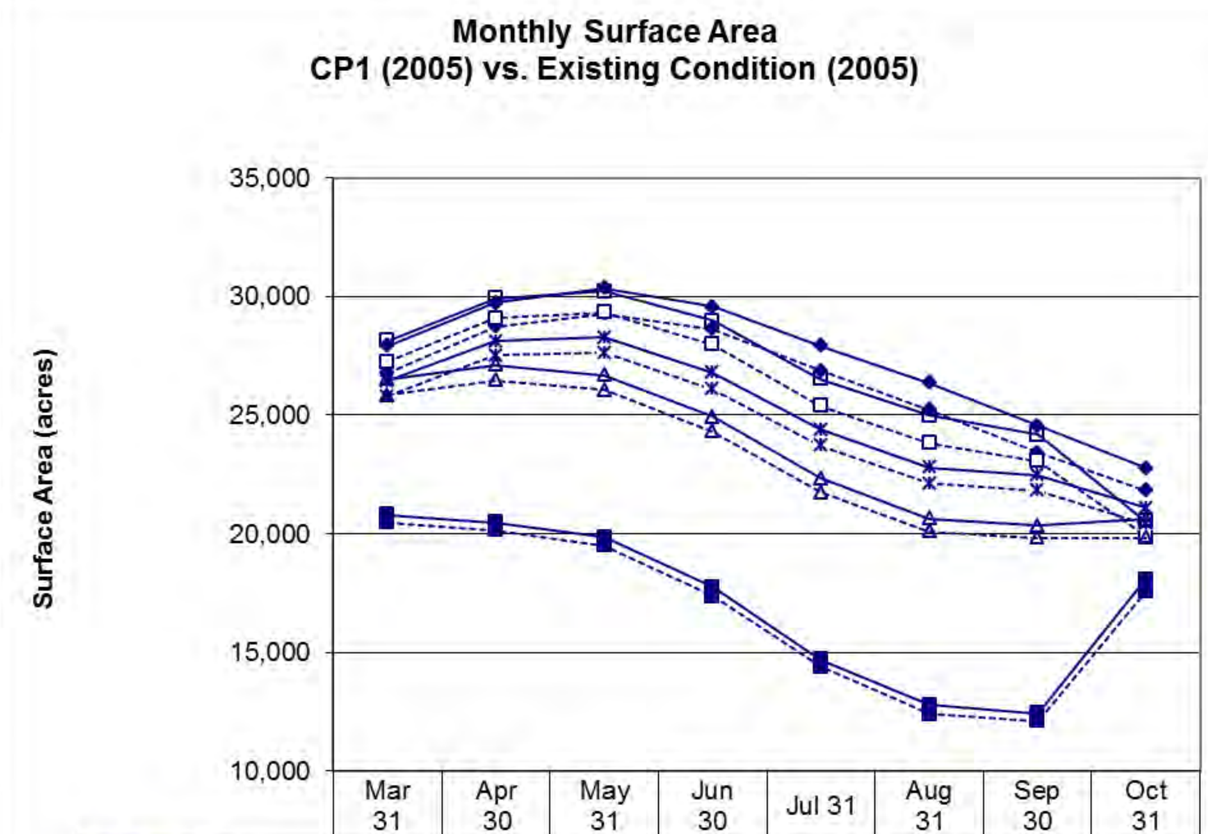
Impact Aqua-1 (CP1): Effects on Nearshore, Warm-Water Habitat in Shasta Lake from Project Operations Under CP1, project operations would contribute to an increase in the surface area and WSEL of Shasta Lake, which would in turn increase the area and productivity of nearshore, warm-water habitat. Project operations would also result in reduced monthly fluctuations in the WSEL, which would contribute to increased reproductive success, young-of-the-year production, and the juvenile growth rate of warm-water fish species. The increase in the WSEL will influence riparian vegetation, including willow species planted to enhance lacustrine habitat, likely resulting in some amount of willow mortality. The increase in the WSEL will also influence the effectiveness of the brush structures that have been installed by the STNF at various locations within the current drawdown zone of Shasta Lake. While the value of these structural improvements will be influenced by an overall increase in the maximum WSEL, these structures will continue to function to varying degrees under the operational conditions established for CP1. The environmental commitments described in Chapter 2, "Alternatives," include maintaining and enhancing brush structures and placing large woody debris and rock/boulder clusters within the CP1 innundation zone. These impacts to structural habitat improvements are expected to be localized and will vary as the brush structures age and riparian vegetation readjusts to a new average reservoir pool elevation. The retention of vegetation along more than 40 percent of the increased shoreline area that would be subject to inundation as a result of CP1 is expected to offset reductions in effective structural habitat improvements for a period of time. The benefits of inundated vegetation will decrease over time (e.g., 10-20 years) as the vegetation decays and the shoreline erosion processes expand into the new drawdown zone. This impact would be less than significant.

Biological productivity is greatest in the upper, lighted layer of the reservoir, where most plankton production occurs. An increase in the surface area of the reservoir could affect warm-water habitat by increasing the area of littoral (nearshore) habitat, which could result in increased biological productivity. Increased inundation of terrestrial habitat, leading to increased nutrient loading from vegetative debris along the shore for some period of time, could increase plankton production, causing an upsurge in nutritional sources for warm-water species (Kimmel and Groeger 1986).

CalSim-II modeling indicated that the surface area of Shasta Lake would be larger under CP1 with a 2005 water supply demand than under the Existing Condition for all five water year types (Figure 11-4). The Shasta Lake surface area would be larger under CP1 with a 2030 water supply demand than under the No-Action Alternative in all five water years (Figure 11-5).

An increase in the WSEL could benefit fish by increasing the amount and quality of available warm-water habitat in Shasta Lake. According to Ozen and Noble (2002), inundation of a reservoir creates an area that is sparsely populated by fish (i.e., decreases fish density per unit of habitat); the low population numbers stimulate the natural reproductive and growth processes of the fish. The newly inundated vegetation creates temporary cover for shoreline-dwelling fishes. As the vegetation decomposes, it releases nutrients for phytoplankton and periphyton, which are in turn consumed by the fish.

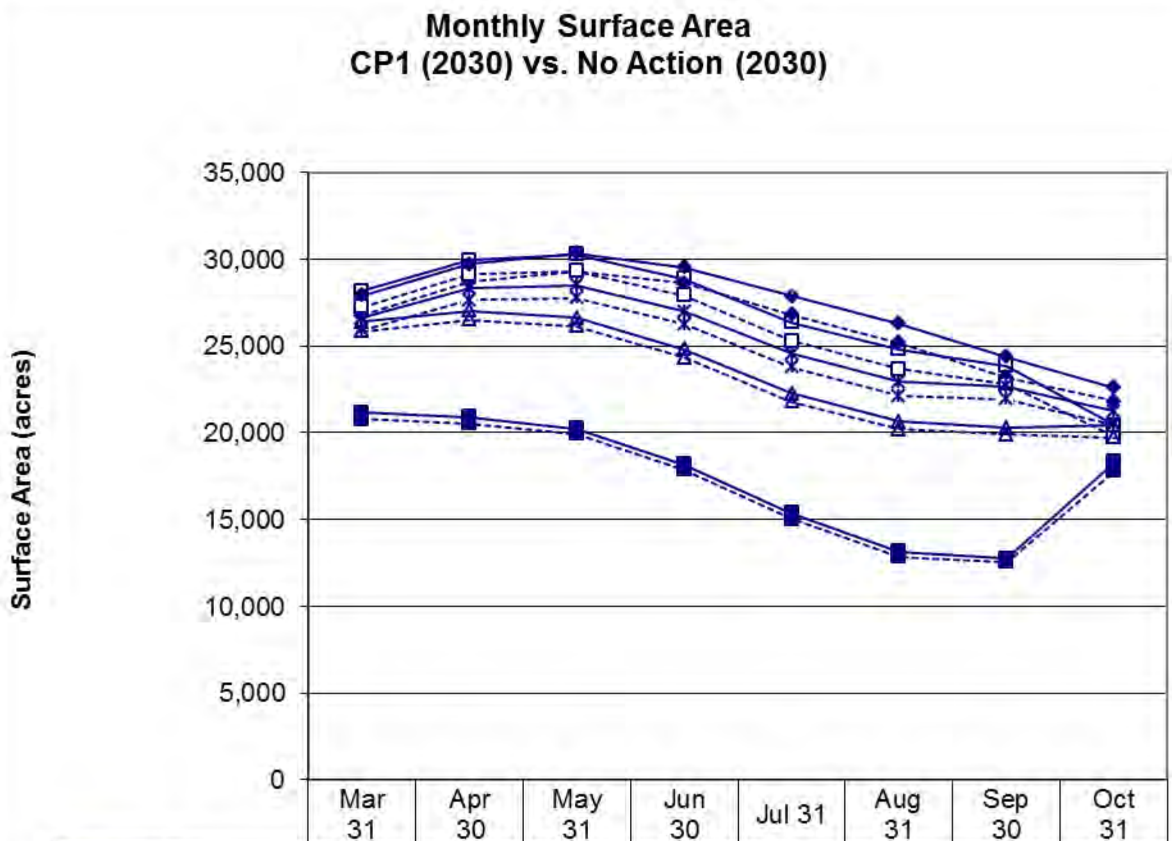
According to CalSim-II modeling, the Shasta Lake WSEL would be higher under CP1 with a 2005 water supply demand than under the Existing Condition for all five water year types. The Shasta Lake WSEL would also be higher under CP1 with a 2030 water supply demand than under the No-Action Alternative in all five water years.



	Mar 31	Apr 30	May 31	Jun 30	Jul 31	Aug 31	Sep 30	Oct 31
EC W	26,790	28,748	29,277	28,624	26,872	25,226	23,413	21,827
EC AN	27,245	29,082	29,336	27,992	25,400	23,826	23,061	19,906
EC BN	25,807	27,534	27,621	26,104	23,714	22,114	21,837	20,425
EC D	25,850	26,467	26,058	24,300	21,754	20,093	19,840	19,828
EC C	20,467	20,142	19,500	17,381	14,400	12,418	12,111	17,572
CP1 2005 W	27,923	29,734	30,345	29,575	27,935	26,353	24,562	22,784
CP1 2005 AN	28,141	29,920	30,228	28,974	26,520	24,980	24,184	20,527
CP1 2005 BN	26,431	28,118	28,273	26,798	24,404	22,790	22,475	21,099
CP1 2005 D	26,520	27,106	26,682	24,934	22,347	20,633	20,348	20,615
CP1 2005 C	20,806	20,488	19,848	17,746	14,716	12,787	12,428	18,087

Key:
AN = above-normal water
BN= below-normal water years
C = critical water years
CP = Comprehensive Plan
D = dry water years
EC = Existing Condition
W = wet water years

Figure 11-4. Average Monthly Surface Area for Each Water Year Type Within the Shasta Lake Vicinity of the Primary Study Area, CP1 Versus the Existing Condition



	Mar 31	Apr 30	May 31	Jun 30	Jul 31	Aug 31	Sep 30	Oct 31
NA W	26,775	28,735	29,273	28,604	26,797	25,183	23,205	21,808
NA AN	27,258	29,117	29,325	27,921	25,294	23,687	22,800	19,759
NA BN	25,918	27,662	27,770	26,239	23,764	22,137	21,923	20,469
NA D	25,843	26,514	26,134	24,346	21,780	20,209	19,910	19,728
NA C	20,801	20,548	19,942	17,866	15,026	12,873	12,556	17,800
CP1 2030 W	27,913	29,722	30,342	29,548	27,861	26,284	24,361	22,615
CP1 2030 AN	28,164	29,959	30,258	28,879	26,366	24,810	23,840	20,432
CP1 2030 BN	26,626	28,325	28,490	26,992	24,551	22,929	22,688	21,244
CP1 2030 D	26,417	27,031	26,615	24,808	22,278	20,626	20,266	20,430
CP1 2030 C	21,154	20,891	20,244	18,157	15,377	13,136	12,759	18,334

Key:
AN = above-normal water
BN= below-normal water years
C = critical water years
CP = Comprehensive Plan
D = dry water years
NA = No-Action
W = wet water years

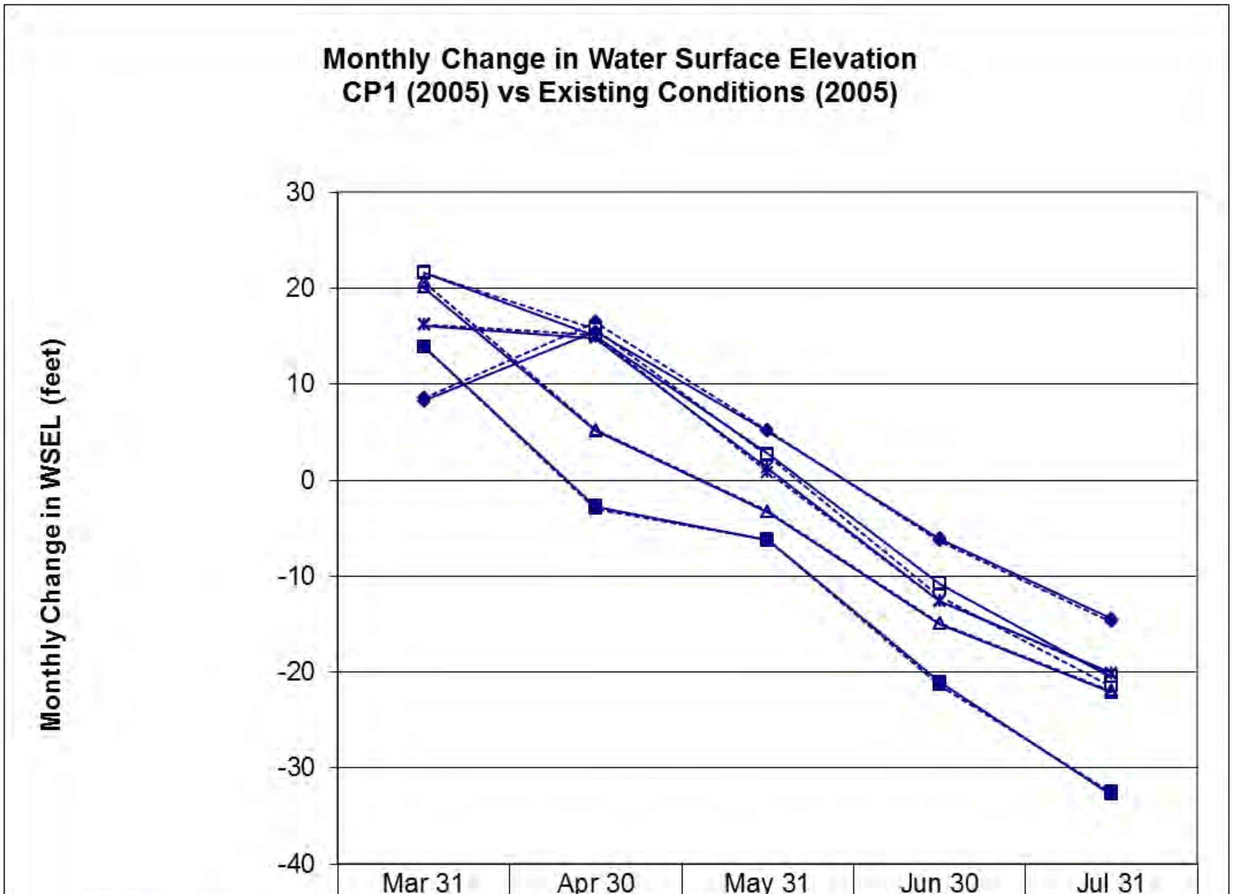
Figure 11-5. Average Monthly Surface Area for Each Water Year Type Within the Shasta Lake Vicinity of the Primary Study Area, CP1 (2030) Versus No-Action Alternative

Rapid rates of increase in WSEL during the critical spring nesting period can lead to such adverse effects as decreased spawning success through nest abandonment or decreased egg survival (Mitchell 1982; Lee 1999). Jones & Stokes (1998) reported that mortality approaches 10 percent for eggs in nests submerged under more than 15 feet of water during periods of rapid increase in reservoir elevations.

Rapidly decreasing WSELs can also have an adverse effect on aquatic organisms. According to Lee (1999), the maximum rate of drawdown that would allow a nesting success rate of 10 percent varied between species, with receding water level rates of less than 0.07, less than 0.03, and less than 0.02 feet per day for largemouth, smallmouth, and spotted bass nests, respectively. Lee found that daily drawdown rates of 0.36, 0.36, and 0.72 feet per day for largemouth, smallmouth, and spotted bass, respectively, resulted in 20-percent nest survival. Under CP1, none of the changes in monthly WSEL fluctuation were substantially different from the Existing Condition.

Monthly WSEL fluctuations were compared with projections for water supply demand. For CP1 with a 2005 water supply demand, 24 percent of monthly changes in projected WSELs (i.e., 6 of the 25 total projections made for the 5 months from March through July for all five water year types) showed decreased monthly WSEL fluctuations relative to the Existing Condition and 4 percent showed a slight increase in monthly WSEL fluctuations (Figure 11-6). For CP1 with a projected 2030 water supply demand, 36 percent of monthly changes in projected WSELs showed decreased WSEL fluctuations relative to the No-Action Alternative and 4 percent showed a slight increase in monthly WSEL fluctuations (Figure 11-7).

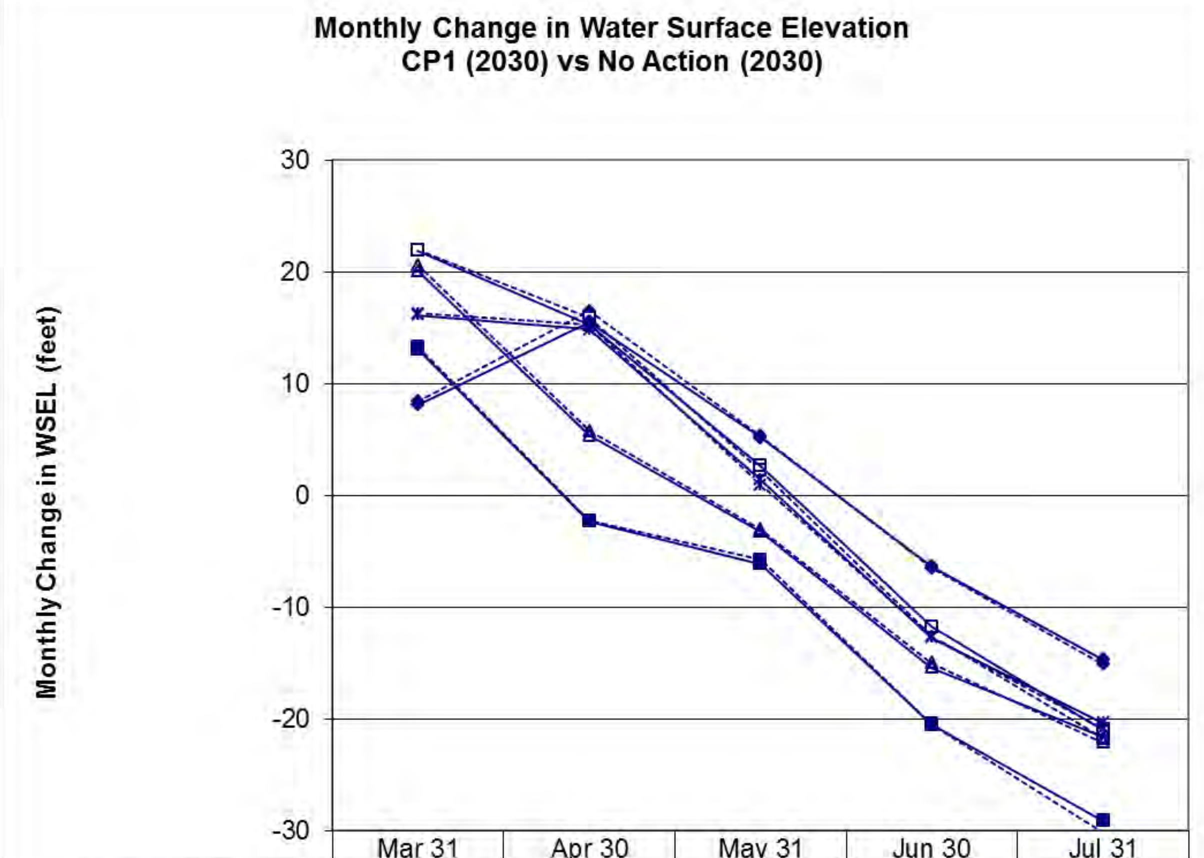
Increases in the overall surface area and WSEL under CP1 would increase the area of available warm-water habitat and stimulate biological productivity, including fish production, of the entire lake, although the value of structural and vegetative improvements that currently provide effective structural habitat at specific locations will be decreased to some extent. This effect will be offset by (1) using brush and trees cleared for other project purposes and placing them in the new inundation varial zone to provide structural fish habitat; (2) identifying locations for planting and monitoring of structural plants such as willows, buttonbrush and cottonwoods (See Chapter 2, "Alternatives," for additional detailed descriptions of the environmental commitments); and (3) retaining newly inundated vegetation along more than 40 percent of the increased shoreline area. Overall, CP1 would result in reductions in the magnitude of monthly WSEL fluctuations and would contribute to increased reproductive success, young-of-the-year production, and juvenile growth rate of warm-water species, and provide for an increase in structural habitat (inundated vegetation) for some period of time. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.



	Mar 31	Apr 30	May 31	Jun 30	Jul 31
EC W	9	16	5	-6	-15
EC AN	22	16	3	-12	-21
EC BN	16	15	1	-13	-20
EC D	21	5	-3	-15	-22
EC C	14	-3	-6	-21	-32
CP1 2005 W	8	15	5	-6	-14
CP1 2005 AN	22	15	3	-11	-21
CP1 2005 BN	16	15	1	-13	-20
CP1 2005 D	20	5	-3	-15	-22
CP1 2005 C	14	-3	-6	-21	-33

Key:
AN = above-normal water
BN = below-normal water years
C = critical water years
CP = Comprehensive Plan
D = dry water years
EC = Existing Condition
W = wet water years
WSEL = water surface elevation

Figure 11-6. Average Monthly Change in WSEL for Each Water Year Type Within the Shasta Lake Vicinity of the Primary Study Area, CP1 Versus the Existing Condition



	Mar 31	Apr 30	May 31	Jun 30	Jul 31
NA W	8	16	5	-7	-15
NA AN	22	16	2	-13	-22
NA BN	16	15	1	-13	-21
NA D	21	6	-3	-15	-22
NA C	13	-2	-6	-21	-30
CP1 2030 W	8	15	5	-6	-15
CP1 2030 AN	22	15	3	-12	-21
CP1 2030 BN	16	15	1	-13	-20
CP1 2030 D	20	5	-3	-15	-22
CP1 2030 C	13	-2	-6	-21	-29

Key:
AN = above-normal water
BN= below-normal water years
C = critical water years
CP = Comprehensive Plan
D = dry water years
NA = No-Action
W = wet water years
WSEL = water surface elevation

Figure 11-7. Average Monthly Change in WSEL for Each Water Year Type Within the Shasta Lake Vicinity of the Primary Study Area, CP1 Versus No-Action Alternative

Impact Aqua-2 (CP1): Effects on Nearshore, Warm-Water Habitat in Shasta Lake from Project Construction Localized increases in soil erosion and resulting runoff sedimentation, and turbidity resulting from project construction in the vicinity of Shasta Dam and at utility, road, and other facility relocation areas could affect nearshore warm-water habitat. However, the environmental commitments described in Chapter 2, "Alternatives," for all action alternatives include the development and implementation of a Construction Management Plan, Erosion and Sediment Control Plan, Stormwater Pollution Prevention Plan (SWPPP), and Revegetation Plan as well as water quality and fisheries conservation measures (e.g., stockpiling of materials for future use as fish habitat structure or installation concurrent with construction activity) and compliance with all required permit terms and conditions. These environmental commitments would result in less-than-significant impacts. Mitigation for this impact is not needed, and thus not proposed.

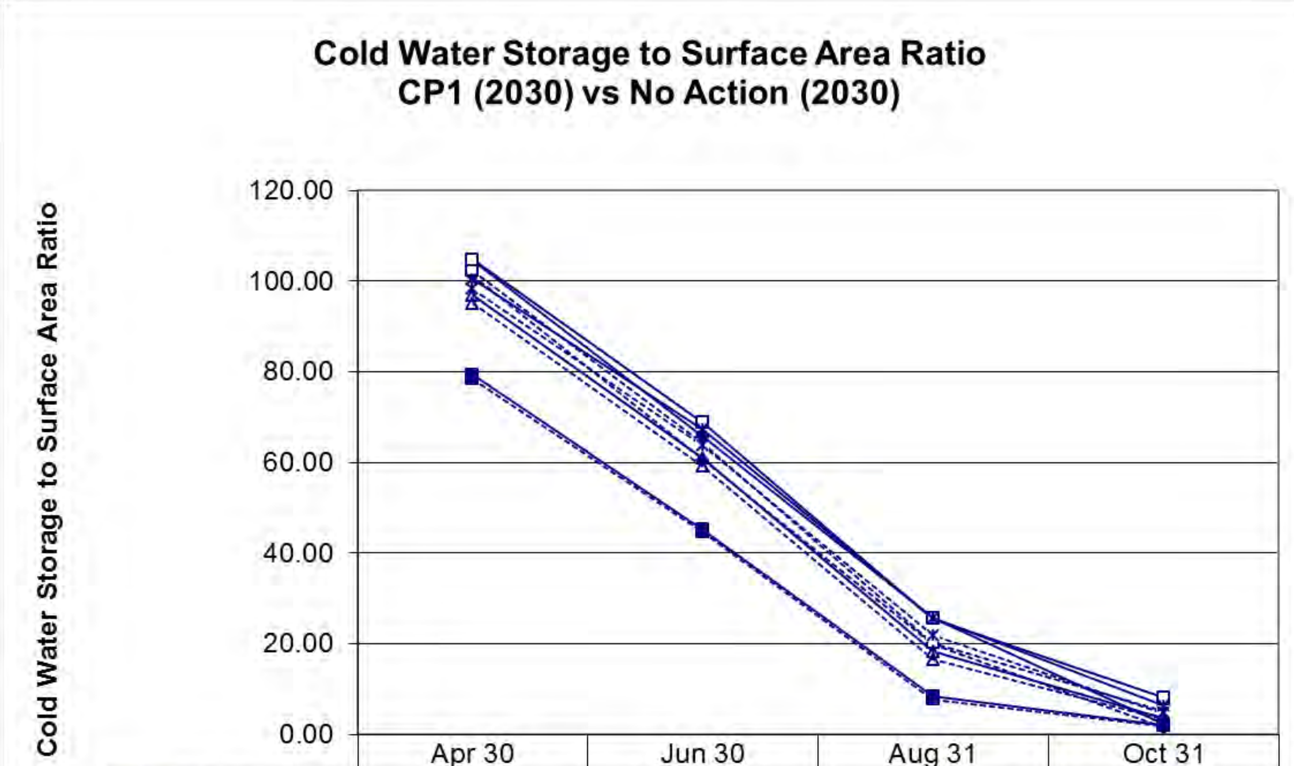
Impact Aqua-3 (CP1): Effects on Cold-Water Habitat in Shasta Lake Under CP1, operations-related changes in the ratio of the volume of cold-water storage to surface area would increase the availability of suitable habitat for cold-water fish in Shasta Lake, including rainbow trout. This impact would be beneficial.

CalSim-II modeling showed that under CP1 with a 2030 water supply demand[3], the ratio of the volume of cold-water storage to surface area was slightly higher than under the No-Action Alternative in all water years and during all months modeled. The greatest projected increases over the No-Action Alternative occurred between June 30 and August 31, which is a critical rearing and oversummering period for cold-water fishes in reservoirs; the increases were highest in wet water years (Figure 11-8). The proportional increase in the cold-water storage to surface area ratio would result in increased cold-water fish productivity (Stables et al. 1990, Jones and Stokes Associates 1988).

CP1 would increase the availability of suitable habitat for cold-water fish in Shasta Lake and would increase cold-water fish production. Therefore, this impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Aqua-4 (CP1): Effects on Special-Status Aquatic Mollusks Under CP1, habitat for special-status mollusks may become inundated. Seasonal fluctuations in the surface area and WSEL of Shasta Lake could also adversely affect special-status aquatic mollusks that may occupy habitat in or near Shasta Lake and its tributaries. This impact would be potentially significant.

[3] Only the 2030 water demand scenario is shown for this reservoir fishery metric because it illustrates the worst case benefit to cold-water fisheries of the water demand scenarios analyzed.



	Apr 30	Jun 30	Aug 31	Oct 31
NA W	101.33	60.49	19.89	1.43
NA AN	102.30	64.04	20.12	5.09
NA BN	98.27	63.71	21.84	4.64
NA D	95.13	59.14	16.50	3.38
NA C	78.43	44.58	7.66	1.82
CP1 2030 W	104.60	65.65	25.58	2.32
CP1 2030 AN	104.79	68.73	25.54	8.10
CP1 2030 BN	100.42	67.24	25.68	6.26
CP1 2030 D	96.84	60.84	18.29	3.64
CP1 2030 C	79.30	45.13	8.32	1.96

Key:
AN = above-normal water
BN= below-normal water years
C = critical water years
CP = Comprehensive Plan
D = dry water years
NA = No-Action
W = wet water years

Figure 11-8. Average Monthly Cold-water Storage to Surface Area Ratio for Each Water Year Type Within the Shasta Lake Vicinity of the Primary Study Area, CP1 Versus No-Action Alternative

The occurrence of special-status mollusks in Shasta Lake and the lower reaches of its tributaries is unlikely. California floaters historically occurred in the tributaries, but have not been observed in recent surveys (Howard 2010, Reclamation 2014). Modification or loss of suitable habitat for the California floater would occur through increased WSEL and seasonal fluctuations in the surface area under CP1. Therefore, this impact would be potentially significant. Mitigation for this impact is proposed in Section 11.3.4, "Mitigation Measures."

Impact Aqua-5 (CP1): Effects on Special-Status Fish Species The expansion of the surface area of Shasta Lake and the inundation of additional tributary habitat under CP1 could affect one species designated as sensitive by USFS known to occur there, the hardhead. This impact would be less than significant.

Two other USFS sensitive species, rough sculpin (in the Pit River) and redband trout (in the upper McCloud River), are known to occur upstream from Shasta Lake, but their presence have not been documented in Shasta Lake or in their respective tributaries within the primary study area. The analysis of the CP1 therefore excludes consideration of these special-status fish species.

Expansion of the surface area of Shasta Lake could be modestly beneficial to hardhead because it could expand the amount of habitat available to this species in the lake, although high annual fluctuations in surface level and the abundance of warm-water predators, primarily sunfishes and basses, in the lake already likely limits the hardhead population there (Moyle 2002, J. Zustak 2007). Hardhead prefer low-gradient, clear and deep (greater than 2.5 feet) flatwater-stream habitat with sand-gravel-boulder substrates, which can be created by the backwater effect of the reservoir within the transition reaches of the main tributaries at their confluence; however, this would not be expected to be much greater than under existing conditions, since reservoir enlargement would simply shift the transition reaches farther upstream in the tributaries.

No hardhead were detected in tributary stream fish surveys in 2011 or 2012 (see *Fisheries and Aquatic Ecosystems Technical Report* for details). Hardhead were not observed in surveys conducted in the Sacramento and McCloud rivers in the vicinity of Shasta Lake (Nevares and Liebig 2007, Weaver and Mehalik 2008), suggesting that this species may not occur in these tributaries or is very uncommon. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Aqua-6 (CP1): Creation or Removal of Barriers to Fish Between Tributaries and Shasta Lake Under CP1, project implementation would result in the periodic inundation of steep and low-gradient tributaries to Shasta Lake up to approximately the 1,080-foot contour, the maximum inundation level under this alternative. This impact would be less than significant.

Potential impacts of reservoir enlargement may occur in areas where fish communities are currently impeded or isolated by passage barriers. Fifty-four percent of the intermittent and 30 percent of the perennial tributaries surveyed in 2012 contained partial or complete barriers to fish migration between the 1,070-foot and 1,090-foot elevation contours. Twenty-two percent of the perennial tributaries (34 total perennial tributaries) and 24 percent (259 total intermittent tributaries) of the intermittent tributaries (of which only 18 percent are potentially fish bearing and only 2 percent of those were fish-bearing in 2012) to Shasta Lake have partial or complete fish passage barriers between the 1,070 and 1,076-foot contours subject to full or partial inundation under CP1. Sixty-one percent of the streams with passage impediments between the 1,070-foot and 1,090-foot contours also had impediments upstream from 1,090-foot contour (i.e., even if downstream barriers were periodically inundated, the length of additional stream habitat that would be accessible to fish from Shasta Lake is limited, particularly in intermittent tributaries).

The likelihood of potential impacts is greater in perennial tributaries as the proportion of these streams bearing fish (87 percent) is much greater than intermittent streams (2 percent) and in tributaries where inundation may create fish passage conditions at existing complete passage barriers. However, the estimated number of streams with complete passage barriers between the 1,070-foot and 1,090-foot contours is only 15 of the 154 perennial tributaries to Shasta Lake (see *Fisheries and Aquatic Ecosystems Technical Report* for details). Five streams with fish passage impediments near the existing full reservoir elevation, including two unnamed intermittent tributaries and three perennial tributaries, Little Squaw Creek, Squaw Creek and Indian Creek. The CP1 reservoir enlargement scenario would at least partially inundate these barriers at a new full pool, potentially allowing fish from the reservoir to immigrate into these streams. This could have a small and localized beneficial effect for adfluvial cold-water fishes in Shasta Lake by increasing the amount of suitable spawning and rearing habitat available for these species.

Inundation of fish passage impediments in tributaries to Shasta Lake would not adversely affect hardhead because: (1) hardhead are uncommon; and (2) it would not facilitate fish passage of predatory warm-water fish species into streams where these species do not already both occur. Under CP1, inundation may create passage opportunities for warm-water fish species into some currently inaccessible portions of these tributaries, which could alter existing resident fish communities in those areas. However, the upstream extent of any colonization by warm-water species is expected to be limited primarily to the newly inundated reaches based on current distribution patterns. With the exception of the main river tributaries (i.e., Sacramento, Pit, and McCloud rivers, and Squaw Creek), less than 10 percent of the lake's currently accessible tributaries have been found to be colonized by warm-water fish upstream from the existing inundation zone.

CP1 would not result in the widespread c*reation or elimination of fish passage barriers in tributaries to Shasta Lake that would affect existing fish communities. However, inundation of a barrier near the mouth of Squaw Creek could potentially allow warm-water fish to move upstream and colonize previously inaccessible habitat with consequent effects on the native fish community and some mollusks, such as California floater, a USFS sensitive* *species. Environmental commitments to monitor fish communities in Squaw Creek and adaptively manage to prevent warm-water fish invasions in Squaw Creek, as described in Chapter 2, "Alternatives," would reduce this impact to a less than significant level.* Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Aqua-7 (CP1): Effects on Spawning and Rearing Habitat of Adfluvial Salmonids in Low-Gradient Tributaries to Shasta Lake CP1 would result in additional periodic inundation of riverine habitat potentially suitable for spawning and rearing habitat for adfluvial salmonids (trout and land-locked salmon that spawn in streams and rear in lakes) in tributaries to Shasta Lake. In addition to modification of the hydraulic regimes of these affected reaches, changes in the WSEL as a result of CP1 will affect the character and location of substrate (e.g., spawning gravel) at some locations, thereby influencing the suitability and availability of spawning and rearing habitat for adfluvial salmonids.

CP1 would inundate perennial stream reaches with gradients of less than 7 percent that could provide suitable spawning and rearing habitat for adfluvial salmonids. Chapter 4, "Geology, Geomorphology, Minerals, and Soils," discusses the periodic inundation of low-gradient stream reaches. The lengths of low-gradient tributaries to each arm of Shasta Lake and estimated suitable spawning habitat areas (both intermittent and perennial) that would be periodically affected are as follows:

- Sacramento Arm – 2.2 miles (7,040 square feet, excludes mainstem river)
- McCloud Arm – 1.1 miles (9,768 square feet)
- Pit Arm – 1.0 mile (355 square feet, excludes mainstem river)
- Big Backbone Arm – 0.5 miles (106 square feet)
- Squaw Arm – 0.6 miles (1,300 square feet)

Only 5.4 miles of low-gradient reaches that could potentially provide some spawning and rearing habitat for adfluvial salmonids (based on channel slope, and confirmed by surveys of representative stream reaches) would be affected by CP1, which is only about 1.4 percent of the low-gradient habitat upstream from Shasta Lake. Although a small proportion of total stream mileage would be affected by CP1, most of the suitable spawning habitat between the 1,070-foot and 1,090-foot contours was estimated to occur in this reach.

Only 7 percent of intermittent streams surveyed contained suitable salmonid spawning habitat between the 1,070-foot and 1,080-foot contours, while 71 percent of perennial streams contained suitable salmonid spawning habitat (see

Fisheries and Aquatic Ecosystems Technical Report for details). The cumulative estimated area of suitable cold-water spawning habitat in all intermittent tributaries to Shasta Lake between the 1,070-foot and 1,080-foot contours was only 205 square feet. Thus, the contribution of intermittent streams, of which only 2 percent are considered to be fish bearing, to spawning and rearing habitat for adfluvial salmonids in Shasta Lake is, collectively, very small. Conversely, approximately 23,253 square feet of suitable cold-water spawning habitat, exclusive of mainstem habitat in the Sacramento and Pit rivers, was estimated to occur within the projected varial zone of perennial tributaries under CP1. This impact would be potentially significant. Mitigation for this impact is proposed in Section 11.3.4, “Mitigation Measures.”

Impact Aqua-8 (CP1): Effects on Aquatic Connectivity in Non-Fish-Bearing Tributaries to Shasta Lake CP1 would result in periodic inundation of varying amounts of non-fish-bearing intermittent tributaries to Shasta Lake. About 12.6 miles of non-fish-bearing tributary habitat would be affected by CP1, which is a length of only about 0.4 percent of non-fish-bearing tributary habitat upstream from Shasta Lake.

As described in Chapter 4, “Geology, Geomorphology, Minerals, and Soils,” CP1 would inundate intermittent tributary segments with channel slopes in excess of 7 percent. Although these segments do not typically support salmonid populations, they do provide riparian and aquatic habitat for a variety of organisms and serve as corridors that connect habitat types. The lengths of non-fish-bearing tributaries based on channel slope (greater than 7 percent) and confirmed by surveys of representative stream reaches for each arm of Shasta Lake that would be periodically inundated are as follows:

- Sacramento Arm – 2.9 miles
- McCloud Arm – 2.1 miles
- Pit Arm – 1.8 miles
- Big Backbone Arm – 1.3 miles
- Squaw Arm – 0.9 miles
- Main Body – 3.6 miles

Surveys of representative tributaries determined that 52 percent of perennial tributaries to Shasta Lake were inhabited by special-status vertebrate species[4], but none occurred in the intermittent tributaries surveyed. No special-status invertebrates (e.g., aquatic mollusks) were detected by casual surveys and benthic sampling of the smaller perennial and intermittent tributaries to Shasta Lake in 2011 or 2012 (see *Fisheries and Aquatic Ecosystems Technical Report*

[4] Hardhead minnow, a USFS sensitive species and foothill yellow-legged frog, a USFS and CDFW sensitive species

for details). Field surveys indicate that few, if any of the non-fish-bearing streams, particularly intermittent ones, contain special-status invertebrate or vertebrate species that would be affected by increased connectivity to Shasta Lake.

Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Aqua-9 (CP1): Effects on Water Quality at Livingston Stone Hatchery Reclamation provides the water supply to the Livingston Stone Hatchery from a pipeline emanating from Shasta Dam. This supply would not be interrupted by any activity associated with CP1. There would be no impact.

This impact is the same as Impact Aqua-9 (No-Action), and there would be no impact. Mitigation for this impact is not needed, and thus not proposed.

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact Aqua-10 (CP1): Loss or Degradation of Aquatic Habitat in the Upper Sacramento River During Construction Activities Temporary construction-related increases in sediments and turbidity levels would adversely affect aquatic habitats and fish populations immediately downstream in the upper Sacramento River. However, environmental commitments would be in place to reduce the effects. This impact would be less than significant.

Increasing the height of Shasta Dam, constructing haul roads, using staging areas, and placing excavated material could disturb sediments and soils within and adjacent to waterways. Any construction-related erosion or disturbance of sediments and soils would temporarily increase downstream turbidity and sedimentation throughout the primary study area if soils were transported in river flows, stormwater runoff, or reservoir water. Such sedimentation and increased turbidity, or other contamination, would be most pronounced in the segment of river from Shasta Dam to Keswick Dam because of the backwater effect that Keswick Reservoir has on flow conditions in the Sacramento River. It is also important to note that Keswick Dam acts as a barrier to upstream fish migration; therefore, all anadromous fish species are downstream from this facility. (See Chapter 7, “Water Quality,” for additional discussion of this issue.)

The abundance, distribution, and survival of fish populations have been linked to levels of turbidity and silt deposition. Prolonged exposure to high levels of suspended sediment would create a loss of visual capability in fish in aquatic habitats within the study area, leading to reduced feeding and growth rates. Such exposure would also result in a thickening of the gills, potentially causing the loss of respiratory function; in clogging and abrasion of gills; and in increased stress levels, which in turn could reduce tolerance to disease and toxicants (Waters 1995, Clark and Wilber 2000, Newcombe and Jensen 1996, Wilber and Clark 2001). Turbidity also could result in increased water temperature and decreased DO levels, especially in low-velocity pools, which can cause stressed respiration.

High levels of suspended sediments could also cause redistribution and movement of fish populations in the upper Sacramento River, and could diminish the character and quality of the physical habitat important to fish survival. Deposited sediments can reduce water depths in stream pools and can contribute to a reduction in carrying capacity for juvenile and adult fish (Waters 1995). Increased sediment loading downstream from construction areas would degrade food-producing habitat, by interfering with photosynthesis of aquatic flora, and could displace aquatic fauna.

Many fish, including salmonids, are sight feeders; turbid waters reduce the ability of these fish to locate and feed on prey. Some fish, particularly juveniles, likely would become disoriented and leave the areas where their main food sources are located, ultimately reducing growth rates.

Prey of fish populations, such as macroinvertebrates, could be adversely affected by declines in habitat quality (water quality and substrate conditions) caused by increased turbidity, decreased DO content, an increased level of pollutants (Coull and Chandler 1992), and (although unlikely) an extreme change in pH or water temperatures (Rundle and Hildrew 1990). Decreases in the diversity and abundance of smaller organisms living on or in the sediments have been associated with smaller sediment grain sizes (Coull 1988) and associated DO decreases in those sediments (Boulton et al. 1991).

Avoidance of adverse habitat conditions by fish is the most common result of increases in turbidity and sedimentation. Fish will not occupy areas unsuitable for survival unless they have no other option. Some fish, such as bluegill and bass species, will not spawn in excessively turbid water (Bell 1990), and salmonids require gravels that are relatively clean and free of excess amounts of fine sediments. Therefore, increased turbidity attributed to construction activities could preclude fish from occupying habitat required for specific life stages. In some locations, few opportunities for escape from turbid waters may be available, particularly during low-flow conditions.

Construction-related sedimentation and increased turbidity or other contamination could temporarily degrade water quality and reduce or adversely affect fish habitat and fish populations in localized areas. However, the environmental commitments for all action alternatives include the development and implementation of best management practices (BMP), including a Construction Management Plan, Erosion and Sediment Control Plan, Storm Water Pollution Prevention Plan (SWPPP), and revegetation plan. Water quality and fisheries conservation measures would also be implemented and project activities would be in compliance with all required permit terms and conditions. With implementation of these environmental commitments, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Aqua-11 (CP1): Release and Exposure of Contaminants in the Upper Sacramento River During Construction Activities Construction-related activities could result in the release and exposure of contaminants. Such exposure could adversely affect aquatic habitats, the aquatic food web, and fish populations, including special-status species, downstream in the primary study area. However, environmental commitments would be in place to reduce the effects. Therefore, this impact would be less than significant.

Contaminants such as fuels, oils, other petroleum products, cement, and various chemicals used during construction could be introduced into the water system directly through accidental spills or incrementally through surface runoff from haul routes and construction sites. In sufficient concentrations, contaminants would be toxic to fish and prey organisms (e.g., benthic macroinvertebrates) occupying habitats in the study area. They also may alter oxygen diffusion rates and cause acute and chronic toxicity to aquatic organisms, thereby reducing growth and survival and/or leading to mortality.

A potential release of hazardous materials into the upper Sacramento River could reduce aquatic habitats and fish populations if proper procedures were not implemented to contain the discharge. However, the environmental commitments for all action alternatives include the development and implementation of a Construction Management Plan, Emergency Response Plan, Erosion and Sediment Control Plan, SWPPP, and revegetation plan. They also include implementation of water quality and fisheries conservation measures and compliance with all required permit terms and conditions. With implementation of these environmental commitments, this impact would be less than significant. Mitigation for this impact is not needed, and thus is not proposed.

Impact Aqua-12 (CP1): Changes in Flow and Water Temperature in the Upper Sacramento River Resulting from Project Operation – Chinook Salmon and Steelhead CP1 operation would result in generally improved flow and water temperature conditions in the upper Sacramento River for Chinook salmon and steelhead relative to both the No-Action Alternative and the Existing Condition, but not all runs show a significant (greater than 5 percent) increase in production. This impact would be less than significant.

Winter-Run Chinook Salmon

Production

CP1 would have a less-than-significant (less than 5 percent) average decrease in winter-run Chinook salmon production relative to the Existing Condition and the No-Action Alternative. The maximum increase in simulated production relative to the No-Action Alternative for CP1 was nearly 23 percent (critical water year). The largest decrease in production relative to the No-Action

Alternative was less than 5 percent (Table 11-5, Figure 11-9, and Attachment 3 of the Modeling Appendix). The largest increase in production relative to the Existing Condition for CP1 was 54 percent, while the largest decrease was -27 percent (Table 11-4 and Attachment 4 of the Modeling Appendix).

Figure 11-9 shows the change in production relative to the No-Action Alternative for all water years and all comprehensive plans. Separating production by water year type to focus on critical water years (when water storage is more reliable) showed an average 0.6-percent increase over the No-Action Alternative, but 2 out of 10 critical water years resulted in a significant (greater than 5 percent) increase in winter-run production relative to the No-Action Alternative, ranging from 0.1 percent to almost 23 percent (Table 11-4).

Table 11-4. Change in Production by Water Year Type Under CP1 for Winter-Run Chinook Salmon

Year Type	No. of Years	Average Production	Change in Production from Baseline	Percent Change in Average Production	Maximum Percent Increase in Production	Number of Years with Significant Increase	Maximum Percent Decrease in Production	Number of Years with Significant Decrease
Future Condition (2030)								
All	81	3,792,084	-9,031	-0.2	22.7	2	-4.9	0
Critical	13	3,397,023	19,067	0.6	22.7	2	-4.8	0
Dry	17	3,973,270	940	0.0	3.3	0	-3.9	0
Below Normal	14	3,943,663	5,104	0.1	2.0	0	-2.0	0
Above Normal	11	3,837,410	-21,520	-0.6	0.9	0	-1.4	0
Wet	26	3,770,350	-31,928	-0.8	2.2	0	-4.9	0
Existing Condition (2005)								
All	81	3,770,537	-10,710	-0.3	54.0	2	-27.3	2
Critical	13	3,225,352	14,413	0.4	54.0	2	-27.3	1
Dry	17	3,975,760	-8,101	-0.2	4.0	0	-1.9	0
Below Normal	14	3,946,894	6,745	0.2	3.0	0	-1.4	0
Above Normal	11	3,839,788	-12,894	-0.3	3.4	0	-3.9	0
Wet	26	3,784,684	-33,452	-0.9	2.2	0	-5.3	1

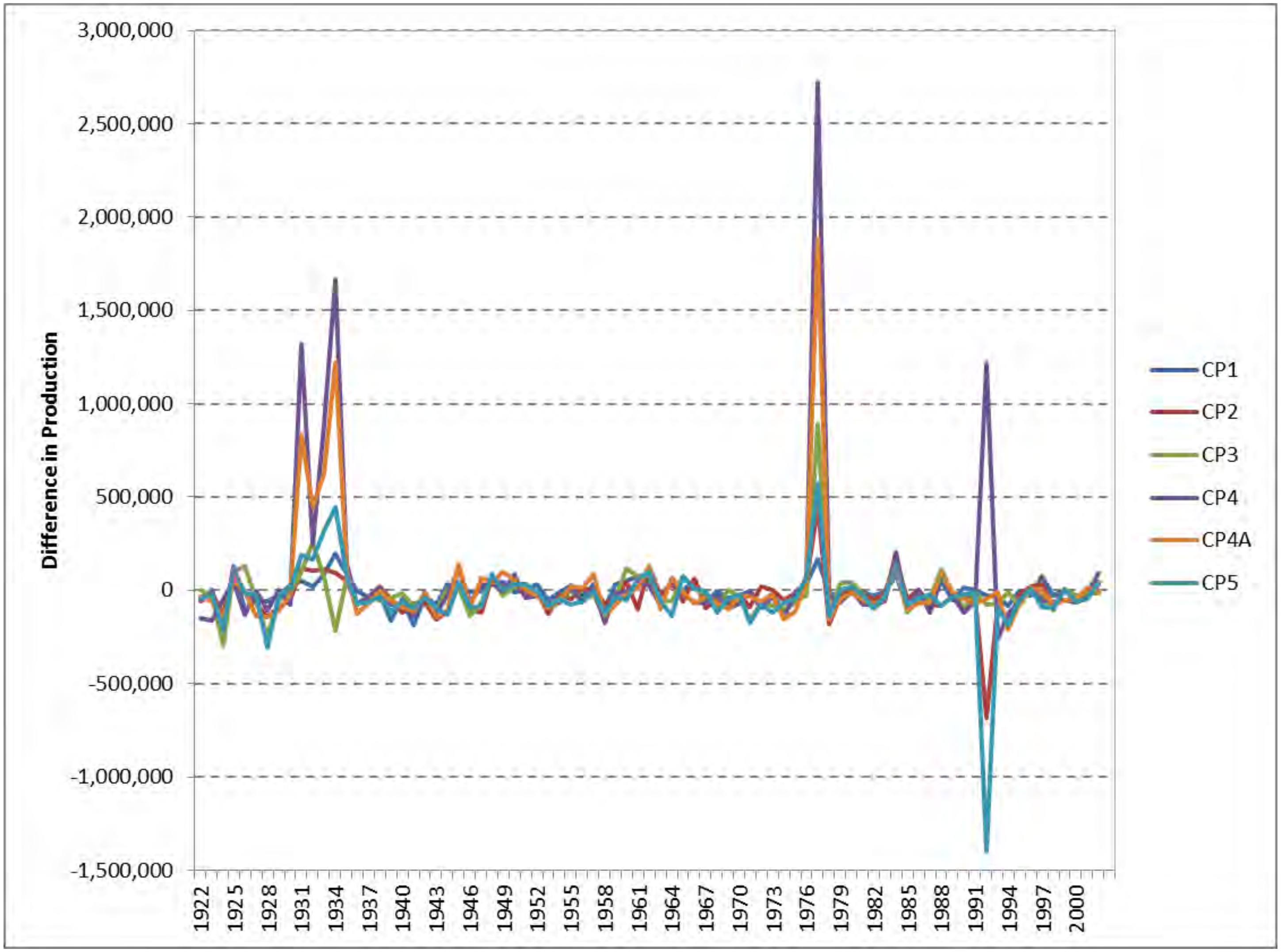
Note:

Production is the number of immature smolts surviving to pass the Red Bluff Pumping Plant

Key:

CP = Comprehensive Plan

No. = number



Key: CP = Comprehensive Plan

Figure 11-9. Change in Production of Winter-Run Chinook Salmon Compared to the No-Action Alternative

CP1 production under 2005 conditions was similar to the Existing Condition. The maximum increase in production was 54 percent for CP1, and the largest decrease in production was less than 5 percent for CP1 (Table 11-4 and Attachment 4 of the Modeling Appendix). Under CP1, 2 out of 10 critical water years resulted in a significant increase in winter-run production relative to the Existing Condition with a maximum of 54 percent; however, water year 1992 resulted in a -27-percent decrease in production. In all other water years, there was an insignificant change in production except for wet water year 1928, which decreased production by -5.3 percent.

Mortality

Mortality was separated by flow- and water temperature-related mortality to assess the level of impacts on winter-run Chinook salmon caused by the actions of the project (Attachments 3 and 4 of the Modeling Appendix). Nonoperations-related mortality are the base and seasonal mortality that would occur even without the effects of Shasta operations (such as disease, predation, and entrainment). Flow- and water temperature-related mortality is that caused by altering flow and water temperatures. In all cases, most mortality is caused by nonoperations-related factors (e.g., disease, predation, entrainment)− around 86 percent of the total mortality.

Mortality is presented in two manners–total mortality and smolt equivalent mortality (Attachments 3 and 4 of the Modeling Appendix). The greatest average mortality to winter-run Chinook salmon under CP1 in all water year types based on smolt equivalents would occur to the fry life stage, followed by eggs, then presmolts, and lastly to immature smolts. Table 11-5 displays the overall mortalities for each Comprehensive Plan that were caused by changes in operations (i.e., water temperature and flow) (Attachments 3 and 4 of the Modeling Appendix).

Years with the highest simulated flow- and water temperature-related mortality were the same for the No-Action Alternative, the Existing Condition, and CP1. Each of these years was a critical water year, and was preceded by either a critical (1976, 1991), or dry (1930, 1932). Years in which the project had the greatest effect, both as an increase and decrease in production were the years in which the lowest production occurs (Attachments 3 and 4 of the Modeling Appendix).

Table 11-5. Average Annual Winter-Run Chinook Salmon Smolt Equivalent Mortality Under Each Base Condition and the Difference in Mortality Under Each Comprehensive Plan Caused by Changes in Flow and Water Temperature

Plan	Egg Count Based on Smolt Equivalent[1,2]	Difference in Mortality Factor from Baseline Condition (in Smolt Equivalents)										Total (in Smolt Equivalents)	Percent Mortality[2]
		Pre-spawn	Incu-bation	Super-Imposition	Eggs Temp	Fry Temp	Fry Habitat	Pre-smolt Temp	Pre-smolt Habitat	Immature Smolt Temp	Immature Smolt Habitat		
Future Condition (2030)													
No-Action Alternative	7,534,801	8	71,606	2,777	36,693	11,848	360,066	13,991	2,750	0	302	500,040	6.6
CP1	7,519,462	0	-3,684	-133	-147	1,306	5,518	524	-229	0	-10	3,143	6.7
CP2	7,489,492	-1	-4,661	-68	2,453	783	12,023	-1,355	-382	0	-29	8,763	6.8
CP3	7,500,867	-1	-4,102	-256	-1,547	958	4,333	-519	-410	0	-55	-1,600	6.6
CP4	7,617,894	0	593	-175	-23,972	-8,403	9,078	-9,165	162	0	-95	-31,976	6.1
CP4A	7,576,083	-1	-3,165	-85	-9,850	-2,181	9,370	-3,786	-356	0	-59	-10,112	6.5
CP5	7,474,687	-1	-7,323	267	2,012	554	11,862	-1,311	-304	0	-13	5,743	6.8
Existing Condition (2005)													
Existing Condition	7,496,582	8	73,885	2,127	43,031	12,704	347,547	13,581	2,560	0	282	495,724	6.6
CP1	7,474,164	0	-3,725	20	-2,847	-1,404	9,423	-1,568	41	0	9	-52	6.6
CP2	7,486,271	0	-3,597	-97	-9,890	-2,013	20,242	-3,413	-142	0	-26	1,063	6.6
CP3	7,508,897	-1	-1,823	-69	-4,143	535	8,189	-2,577	-135	0	-9	-31	6.6
CP4	7,626,344	0	708	119	-28,096	-9,099	14,407	-9,017	26	1	4	-30,948	6.1
CP4A	7,582,763	0	-1,441	-93	-17,947	-4,448	15,327	-5,911	-170	0	-10	-14,693	6.3
CP5	7,467,882	0	-6,156	135	-4,983	-1,490	14,976	-2,994	-234	0	-25	-771	6.6

Notes:

[1] The potential number of smolt equivalent is based on the spawning population of 8,591 adults, using the formula:
Immature Smolt Equivalent Mortality = Mortality * % Survival $_{(eggs\ to\ fry)}$ * % Survival $_{(fry\ to\ presmolts)}$ * % Survival $_{(presmolts\ to\ immature\ smolts)}$

[2] Values in these two columns do not constitute a difference from the baseline condition.

Key:

CP = Comprehensive Plan

Because winter-run Chinook salmon would have an insignificant change (1 percent or less) in flow- and water temperature-related mortality under CP1, and an insignificant change in production (less than 5 percent overall), a less-than-significant impact to winter-run Chinook salmon would occur from actions taken in CP1. Mitigation for this impact is not needed, and thus not proposed.

Spring-Run Chinook Salmon

Production

Spring-run Chinook salmon production for the 81-year period does not change significantly between CP1 and the No-Action Alternative and the Existing Condition (Attachments 6 and 7 of the Modeling Appendix). The maximum increase in production relative to the No-Action Alternative was around 71 percent for CP1, while the largest decrease in production relative to the No-Action Alternative was -66 percent, both in critical water years (Table 11-6, Figure 11-10, and Attachment 6 of the Modeling Appendix). The maximum increase in production relative to the Existing Condition was 256 percent for CP1, while the largest decrease in production relative to the Existing Condition was -41 percent, also both in critical water years (Table 11-6, Figure 11-10, and Attachment 7 of the Modeling Appendix).

Figure 11-10 shows the change in production relative to the No-Action Alternative for all water years and all Comprehensive Plans. Separating production by water year type to focus on critical years in which production was the lowest under the No-Action Alternative typically had the largest increase under CP1 conditions, except for 1977 and 1992, which had 12 percent and 52 percent reductions, respectively (Attachment 6 of the Modeling Appendix).

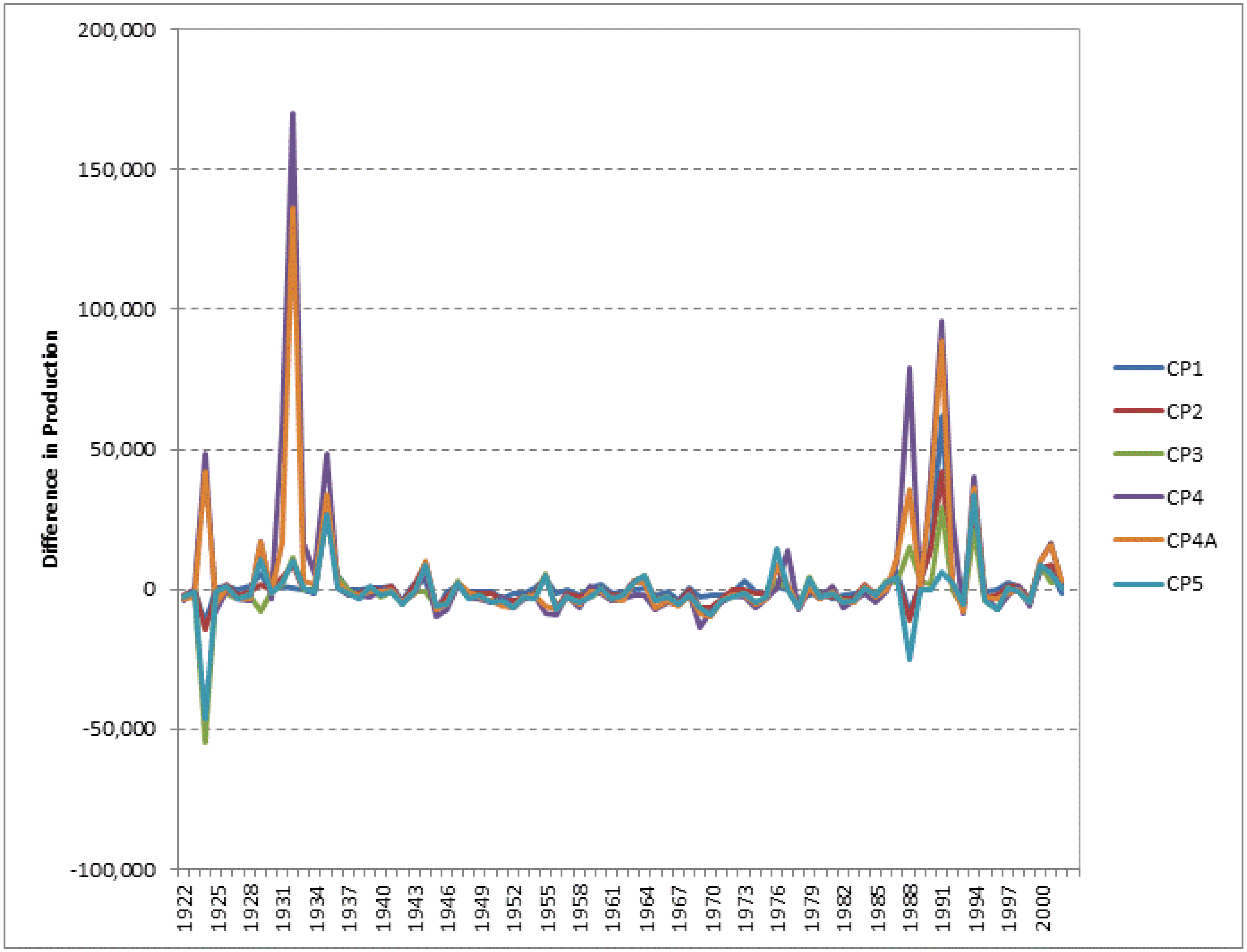
Compared to the No-Action Alternative, six critical, one dry, and one below-normal water years had significant increases in production, while three critical water years have a significant decrease in production (Table 11-6 and Attachment 6 of the Modeling Appendix). Compared to the Existing Condition, nine critical and two dry water years had significant increases in production, while one critical water years resulted in significant decreases in production (Table 11-6 and Attachment 7 of the Modeling Appendix).

Table 11-6. Change in Production Under CP1 for Spring-Run Chinook Salmon

Year Type	Number of Years	Average Production	Change in Production from Baseline	Percent Change in Average Production	Maximum Percent Increase in Production	Number of Years with Significant Increase	Maximum Percent Decrease in Production	Number of Years with Significant Decrease
Future Condition (2030)								
All	81	165,227	1,172	0.7	70.6	8	-66.3	3
Critical	13	88,867	7,677	9.5	70.6	6	-66.3	3
Dry	17	170,150	698	0.4	7.2	1	-2.1	0
Below Normal	14	178,425	1,245	0.7	19.8	1	-4.3	0
Above Normal	11	183,396	-370	-0.2	3.3	0	-2.5	0
Wet	26	185,393	-1,158	-0.6	1.1	0	-2.2	0
Existing Condition (2005)								
All	81	164,198	990	0.6	256	11	-41.3	1
Critical	13	83,012	8,950	12.1	256	9	-41.3	1
Dry	17	170,380	1,519	0.9	16.5	2	-1.0	0
Below Normal	14	177,394	-636	-0.4	1.7	0	-2.1	0
Above Normal	11	182,943	-1,170	-0.6	2.2	0	-2.3	0
Wet	26	185,713	-1,546	-0.8	1.7	0	-3.1	0

Note:

Production is the number of immature smolts surviving to pass the Red Bluff Pumping Plant



Key: CP = Comprehensive Plan

Figure 11-10. Change in Production of Spring-Run Chinook Salmon Compared to the No-Action Alternative

Mortality

Mortality was separated by flow- and water temperature-related mortality to assess the level of impacts on spring-run Chinook salmon caused by the actions of the project (Attachments 6 and 7). In all cases, most mortality is caused by nonoperations-related factors (e.g., disease, predation, entrainment)‒around 83 percent of the total mortality.

Mortality is presented in two manners–total mortality and smolt equivalent mortality (Attachments 6 and 7 of the Modeling Appendix). Under both the 2030 and 2005 conditions, the greatest mortality to spring-run occurred to eggs, with minimal mortality to the other life stages. Table 11-7 displays the smolt-equivalent mortalities for each Comprehensive Plan that are caused by flow- and water-related factors (also see Attachments 6 and 7 of the Modeling Appendix). In both 2030 and 2005 conditions, only eggs and fry would be affected by operation of the Comprehensive Plans (Table 11-7 and Attachments 6 and 7 of the Modeling Appendix). In all but wet water years, mortality to eggs due to unsuitable water temperatures would be the primary cause of operations-related mortalities (Attachments 6 and 7 of the Modeling Appendix).

Years with the highest flow- and water temperature-related mortality were the same for all the Comprehensive Plans. Except in 1932 (a dry water year), each of these years was a critical water year type and was preceded by either a below, dry, or (predominantly) critical water year. However, years with the lowest mortality varied between all but critical water year types (Attachments 6 and 7 of the Modeling Appendix).

Spring-run Chinook salmon would have, overall, an insignificant change flow- and water temperature-related mortality, and an insignificant increase in production for all 82 years. However, spring-run Chinook salmon would have a significant increase in production in critical water years. Therefore, spring-run Chinook salmon would benefit from actions taken in CP1. Mitigation for this impact is not needed, and thus not proposed.

Table 11-7. Average Annual Spring-Run Chinook Salmon Smolt Equivalent Mortality Under Each Base Condition and the Difference in Mortality Under Each Comprehensive Plan Caused by Changes in Flow and Water Temperature

Plan	Egg Count Based on Smolt Equivalent[1,2]	Difference in Mortality Factor from Baseline Condition (in Smolt Equivalents)										Total (in Smolt Equivalents)	Percent Mortality[2]
		Pre-spawn	Incu-bation	Super-Impo-sition	Eggs Temp	Fry Temp	Fry Habitat	Pre-smolt Temp	Pre-smolt Habitat	Immature Smolt Temp	Immature Smolt Habitat		
Future Condition (2030)													
No-Action Alternative	302,510	106	1,328	0	6,189	0	29	0	0	0	0	7,653	2.5
CP1	304,299	-7	82	0	-1,382	0	1	0	0	0	0	-1,306	2.1
CP2	303,633	-3	-35	0	-1,467	0	-2	0	0	0	0	-1,507	2.0
CP3	301,437	-8	17	0	-1,170	0	-5	0	0	0	0	-1,166	2.2
CP4	313,315	-23	415	0	-2,829	0	-3	0	0	0	0	-2,440	1.7
CP4A	309,815	-21	145	0	-2,609	0	-3	0	0	0	0	-2,488	1.7
CP5	300,918	10	-16	0	-1,654	0	-3	0	0	0	0	-1,664	2.0
Existing Condition (2005)													
Existing Condition	300,637	126	1,124	0	6,155	0	27	0	0	0	0	7,432	2.5
CP1	302,611	-4	-40	0	-861	0	3	0	0	0	0	-902	2.2
CP2	304,787	-14	44	0	-1,548	0	2	0	0	0	0	-1,517	1.9
CP3	303,602	1	128	0	-1,308	0	-3	0	0	0	0	-1,181	2.1
CP4	313,736	-45	305	0	-2,754	0	5	0	0	0	0	-2,489	1.6
CP4A	311,104	-27	212	0	-2,465	0	-1	0	0	0	0	-2,281	1.7
CP5	302,329	-1	67	0	-1,718	0	-2	0	0	0	0	-1,654	1.9

Note:

[1] The potential number of smolt equivalent is based on the spawning population of 207 adults, using the formula:
Immature Smolt Equivalent Mortality = Mortality * % Survival $_{(eggs\ to\ fry)}$ * % Survival $_{(fry\ to\ presmolts)}$ * % Survival $_{(presmolts\ to\ immature\ smolts)}$

[2] Values in these two columns do not constitute a difference from the baseline condition.

Key:
CP = Comprehensive Plan

Fall-Run Chinook Salmon

Production

The overall average fall-run Chinook salmon production for the 81-year period was similar for CP1 relative to the No-Action Alternative and the Existing Condition (Attachments 9 and 10 of the Modeling Appendix). The maximum increase in production relative to the No-Action Alternative was 17 percent for CP1. The largest decrease in production relative to the No-Action Alternative was 51 percent for CP1 (Table 11-8 and Attachment 9 of the Modeling Appendix). The maximum increase in production relative to the Existing Condition was 61 percent for CP1. The largest decrease in production relative to the Existing Condition was 5 percent for CP1 (Table 11-8 and Attachment 10 of the Modeling Appendix).

Figure 11-11 shows the annual change in production relative to the No-Action Alternative for all Comprehensive Plans.

Under CP1, three critical water years, two dry water years, and one below-normal water year resulted in increases in production relative to the No-Action Alternative greater than 5 percent. Only critical water year resulted in a significant decrease (more than 5 percent) in production relative to the No-Action (Attachment 9 of the Modeling Appendix).

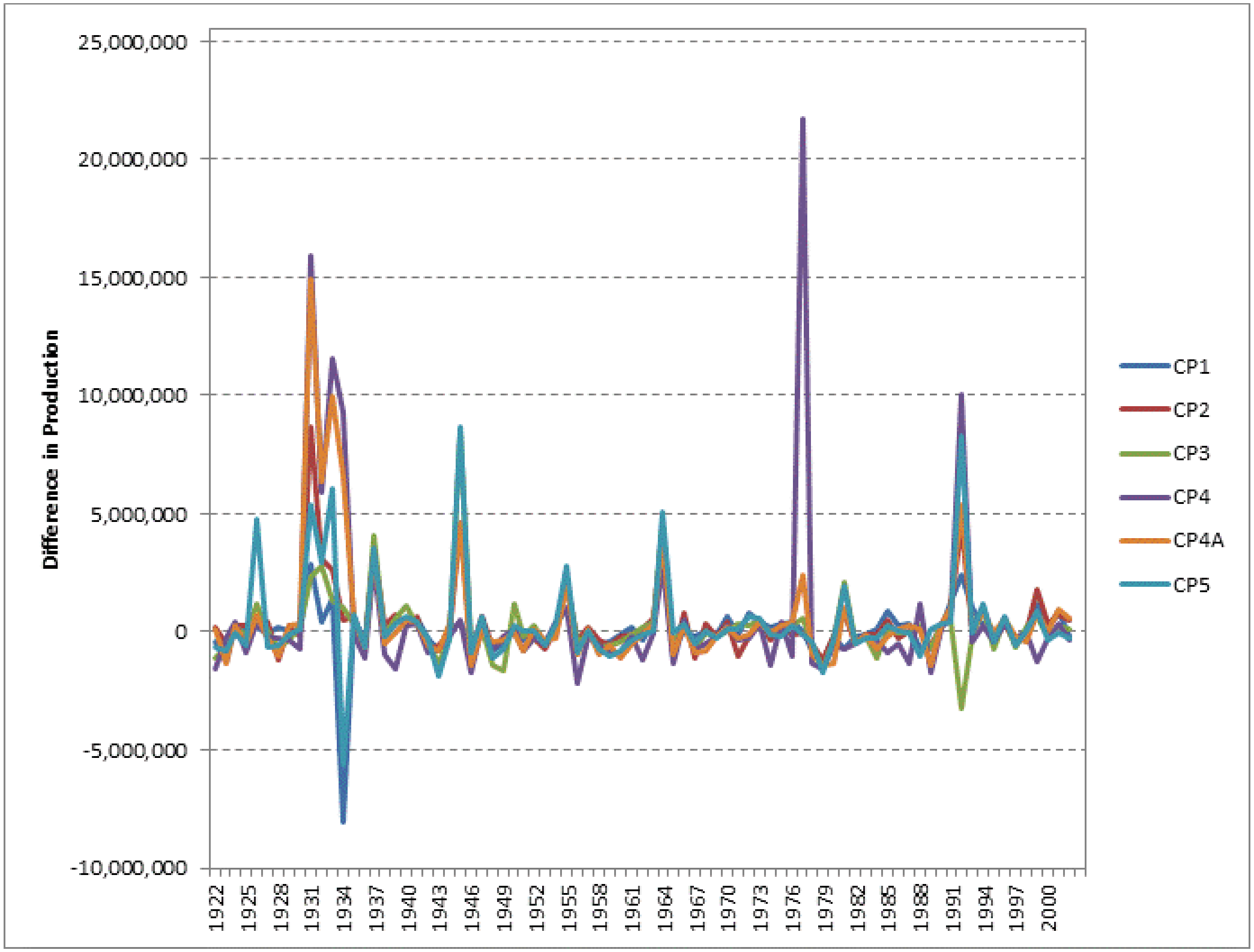
Under CP1, one critical and one dry water year resulted in significant increases in production relative to the Existing Condition greater than 5 percent. Critical water years 1977 and 1992 and wet water years 1929 and 1992 resulted in significant decreases in production relative to the Existing Condition greater than 5 percent.

Table 11-8. Change in Production Under CP1 for Fall-Run Chinook Salmon

Year Type	Number of Years	Average Production	Change in Production from Baseline	Percent Change in Average Production	Maximum Percent Increase in Production	Number of Years with Significant Increase	Maximum Percent Decrease in Production	Number of Years with Significant Decrease
Future Condition (2030)								
All	81	29,597,665	79,258	0.3	17.2	6	-51.3	1
Critical	13	26,551,960	107,131	0.4	14.6	3	-51.3	1
Dry	17	29,819,701	279,541	0.9	12.7	2	-3.3	0
Below Normal	14	31,090,422	-7,489	0.0	17.2	1	-4.6	0
Above Normal	11	31,088,575	55,565	0.2	4.1	0	-2.3	0
Wet	26	29,540,778	-8,898	0.0	4.8	0	-4.3	0
Existing Condition (2005)								
All	81	29,743,213	314,871	1.1	61.1	8	-4.5	0
Critical	13	27,135,675	959,539	3.7	61.1	3	-3.6	0
Dry	17	29,933,697	473,296	1.6	12.1	3	-2.4	0
Below Normal	14	31,504,560	486,298	1.6	24.3	2	-3.6	0
Above Normal	11	30,856,686	-13,710	0.0	2.5	0	-1.9	0
Wet	26	29,502,932	-64,339	-0.2	3.8	0	-4.5	0

Note:

Production is the number of immature smolts surviving to pass the Red Bluff Pumping Plant



Key: CP = comprehensive Plan

Figure 11-11. Change in Production of Fall-Run Chinook Salmon Compared to the No-Action Alternative

Mortality

Mortality was separated by flow- and water temperature-related mortality to assess the level of impacts on fall-run Chinook salmon caused by the actions of the project (Attachments 9 and 10). In all cases, most mortality is caused by nonoperations-related factors (e.g., disease, predation, entrainment)−around 64 percent of the total mortality.

Mortality is presented in two manners–total mortality and smolt equivalent mortality (Attachments 9 and 10 of the Modeling Appendix). Under both 2030 and 2005 conditions, the greatest mortality based on the smolt equivalents to fall-run Chinook salmon under CP1 occurred to fry, followed by eggs, prespawn adults, presmolts, and lastly to immature smolts. Flow-related effects triggered a higher percentage of the operations-related mortality (Table 11-9). In all water year types, the greatest portion of mortality under CP1 occurred to fry caused by forced movement to downstream habitats. Other non-flow- and water temperature-related conditions were the primary causes of mortality for all life stages except fry (Attachments 9 and 10 in the Modeling Appendix).

Most differences in production and mortality are insignificant for fall-run Chinook salmon. Therefore, there would be a less-than-significant impact to fall-run Chinook salmon. Mitigation for this impact is not needed, and thus not proposed.

Table 11-9. Average Annual Fall-Run Chinook Salmon Smolt Equivalent Mortality Under Each Base Condition and the Difference in Mortality Under Each Comprehensive Plan Caused by Changes in Flow and Water Temperature

Plan	Egg Count Based on Smolt Equivalent [1,2]	Difference in Mortality Factor from Baseline Condition (in Smolt Equivalents)										Total (in Smolt Equivalents)	Percent Mortality[2]
		Pre-spawn	Incu-bation	Super-Impo-sition	Eggs Temp	Fry Temp	Fry Habitat	Pre-smolt Temp	Pre-smolt Habitat	Immature Smolt Temp	Immature Smolt Habitat		
Future Condition (2030)													
No-Action Alternative	53,997,584	532,611	698,320	1,098,998	130,219	1,098	7,297,067	6,839	191,817	3,554	15,051	9,975,575	18.5
CP1	54,020,735	-82,771	-7,088	-29,273	-14,950	-77	60,531	-594	-7,185	-283	-1,168	-82,858	18.3
CP2	54,623,098	-66,868	-13,920	-9,913	4,390	95	83,271	657	-19,704	-416	-1,198	-23,605	18.2
CP3	54,307,062	-10,196	-18,624	-44,357	-16,910	188	91,866	52	-16,532	-585	-2,444	-17,543	18.3
CP4	55,174,850	-196,088	1,013	-35,321	-29,663	-46	417,965	284	8,577	-867	-595	165,258	18.4
CP4A	55,083,176	-197,542	-8,550	-12,979	-8,064	102	320,399	413	-3,513	-1,142	-126	88,998	18.3
CP5	54,516,383	-148,596	-19,715	-22,701	24,634	193	87,028	1,389	-14,705	-248	-1,230	-93,952	18.1
Existing Condition (2005)													
Existing Condition	53,773,316	508,244	691,873	1,107,388	119,149	1,144	7,272,250	6,199	192,979	3,408	14,665	9,917,299	18.4
CP1	54,339,007	-2,695	-6,984	-8,457	7,564	-90	55,007	1,207	-4,141	414	805	42,629	18.3
CP2	54,186,119	-203,671	-12,659	-8,650	15,915	-78	74,966	860	-8,525	-310	-1,349	-143,502	18.0
CP3	54,439,932	-40,503	-12,017	-35,451	3,131	-93	76,845	260	-9,640	-691	-1,242	-19,400	18.2
CP4	55,250,903	-212,958	1,638	-15,390	-11,051	-77	317,170	1,956	5,951	-371	2,284	89,152	18.1
CP4A	54,625,226	-204,673	-7,375	-14,307	-7,220	-83	163,730	725	-12,903	-1,205	261	-83,050	18.0
CP5	54,821,535	15,805	-17,399	-40,060	42,336	-66	82,328	2,931	-4,389	77	-1,594	79,967	18.2

Notes:

[1] The potential number of smolt equivalent is based on the spawning population of 64,565 adults, using the formula:
Immature Smolt Equivalent Mortality = Mortality * % Survival $_{\text{(eggs to fry)}}$ * % Survival $_{\text{(fry to presmolts)}}$ * % Survival $_{\text{(presmolts to immature smolts)}}$

[2] Values in these two columns do not constitute a difference from the baseline condition.

Key:

CP = Comprehensive Plan

Late Fall-Run Chinook Salmon and Steelhead

Late fall-run Chinook salmon were evaluated directly using SALMOD and were considered to be a surrogate for steelhead; therefore, the following discussion regarding SALMOD results for late fall-run Chinook salmon are applicable to steelhead.

Production

Overall average late fall-run Chinook salmon production for the 80-year period was similar for CP1 relative to the No-Action Alternative. The maximum increase in production relative to the No-Action Alternative was almost 9 percent for CP1, while the largest decrease in production relative to the No-Action Alternative was less than 5 percent for CP1 (Table 11-10 and Attachment 12 of the Modeling Appendix).

Overall average late fall-run Chinook salmon production for the 80-year period was similar for CP1 relative to Existing Conditions. There were two critical water years with a significant increase (greater than 5 percent) in production, and no years with significant decreases in production relative to Existing Conditions (Table 11-10 and Attachment 13 of the Modeling Appendix).

Figure 11-12 and Table 11-10 display the annual differences in production for late fall-run Chinook salmon for all Comprehensive Plans.

Table 11-10. Change in Production Under CP1 for Late Fall-Run Chinook Salmon

Year Type	Number of Years	Average Production	Change in Production from Baseline	Percent Change in Average Production	Maximum Percent Increase in Production	Number of Years with Significant Increase	Maximum Percent Decrease in Production	Number of Years with Significant Decrease
Future Condition (2030)								
All	80	7,408,364	-10,122	-0.1	8.8	1	-3.8	0
Critical	13	7,038,385	-25,783	-0.4	3.6	0	-3.7	0
Dry	16	7,394,185	39,817	0.5	8.8	1	-1.7	0
Below Normal	14	7,598,833	-13,785	-0.2	2.6	0	-2.5	0
Above Normal	11	7,543,667	-42,417	-0.6	3.1	0	-2.6	0
Wet	26	7,442,276	-17,388	-0.2	3.6	0	-3.8	0
Existing Condition (2005)								
All	80	7,425,077	38,516	0.5	9.4	2	-4.0	0
Critical	13	7,029,066	65,770	0.9	5.3	1	-2.5	0
Dry	16	7,443,310	83,042	1.1	9.4	1	-2.7	0
Below Normal	14	7,642,832	31,738	0.4	4.6	0	-2.9	0
Above Normal	11	7,578,729	19,056	0.3	1.5	0	-0.6	0
Wet	26	7,429,604	9,372	0.1	3.8	0	-4.0	0

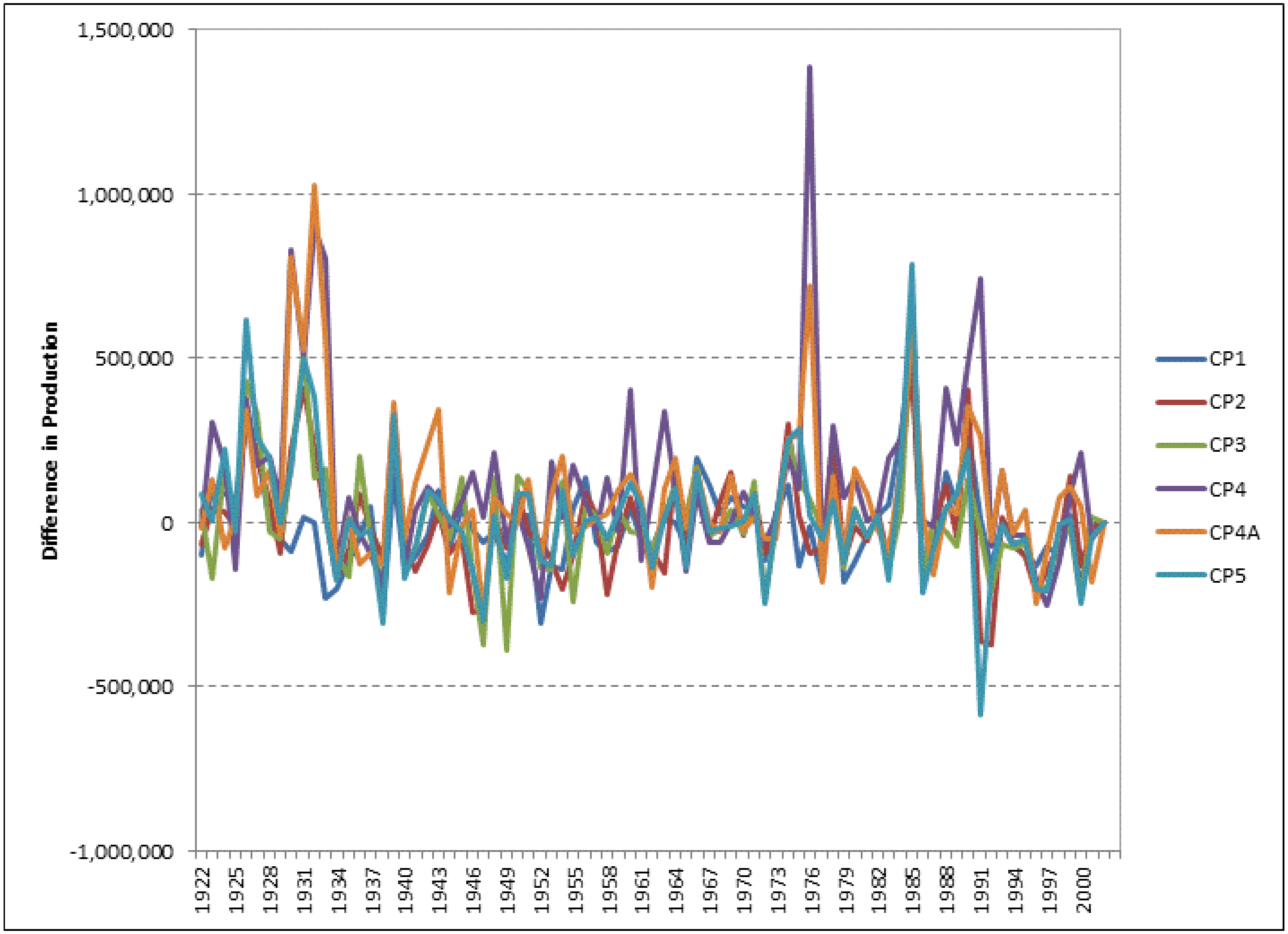
Notes:

Production is the number of immature smolts surviving to pass the Red Bluff Pumping Plant

Late fall-run Chinook salmon are used as a surrogate for steelhead

Key:

CP = Comprehensive Plan



Note: Late fall-run Chinook salmon are used as a surrogate for steelhead
Key: CP = Comprehensive Plan

Figure 11-12. Change in Production of Late Fall-Run Chinook Salmon Compared to the No-Action Alternative

Mortality

Mortality was separated by flow- and water temperature-related mortality to assess the level of impacts on late fall-run Chinook salmon caused by the actions of the project (Attachments 12 and 13 of the Modeling Appendix). In all cases, most mortality is caused by nonoperations-related factors (e.g., disease, predation, entrainment)−around 78 percent of the total mortality.

Mortality is presented in two manners–total mortality and smolt equivalent mortality (Attachments 12 and 13 of the Modeling Appendix). Under both 2030 and 2005 conditions, the largest mortality to late fall-run Chinook salmon under CP1 occurred to fry, followed by eggs, presmolts, immature smolts, and prespawn adults. Table 11-11 displays the overall mortalities for each Comprehensive Plan that are caused by changes in water temperature and flow (see also Attachments 12 and 13 of the Modeling Appendix).

When comparing mortality for flow- and water temperature-related activities only, fry are most affected, followed by eggs, presmolts, and immature smolts. Most mortality occurred as a result of flow conditions rather than water temperature (Table 11-11).

Years with the highest mortality under CP1 occurred in all water year types under both 2030 and 2005 conditions. Three years were preceded by a wet water year, one was preceded by an above-normal water year, and one was preceded by a dry water year (see also Attachments 12 and 13 of the Modeling Appendix).

Because SALMOD indicates an insignificant change in mortality and production index for late fall-run Chinook salmon, late fall-run Chinook salmon and steelhead (as represented by their surrogate late fall-run Chinook salmon) would experience a less-than-significant impact from actions taken in CP1. Mitigation for this impact is not needed, and thus not proposed.

Table 11-11. Average Annual Late Fall-Run Chinook Salmon Smolt Equivalent Mortality Under Each Base Condition and the Difference in Mortality Under Each Comprehensive Plan Caused by Changes in Flow and Water Temperature

Plan	Egg Count Based on Smolt Equivalent[1,2]	Difference in Mortality Factor from Baseline Condition (in Smolt Equivalents)										Total (in Smolt Equivalents)	Percent Mortality[2]
		Pre-spawn	Incu-bation	Super-Imposition	Eggs Temp	Fry Temp	Fry Habitat	Pre-smolt Temp	Pre-smolt Habitat	Immature Smolt Temp	Immature Smolt Habitat		
Future Condition (2030)													
No-Action	16,503,033	1,185	147,828	238,486	10,869	862	1,653,260	51,100	13,496	37,528	1,880	2,156,493	13.1
CP1	16,482,647	-21	-4,485	-12,202	12	62	21,041	241	185	36,023	1,899	3,349	13.1
CP2	16,486,201	0	-6,986	-20,836	10	158	28,285	-940	421	31,864	1,847	-5,585	13.0
CP3	16,494,636	4	-6,649	-23,415	-30	-137	20,945	-3,718	-911	33,980	1,810	-17,529	13.0
CP4	16,687,864	5	-4,074	-11,329	456	-796	19,653	-42,691	1,803	15,383	2,298	-58,698	12.6
CP4A	16,624,011	12	-6,261	-20,225	389	-649	18,736	-25,719	150	24,662	2,062	-46,250	12.7
CP5	16,505,875	6	-7,951	-23,658	109	24	17,280	-1,925	-612	33,042	1,818	-21,276	12.9
Existing Condition (2005)													
Existing Condition	16,452,992	1,024	150,329	233,909	10,938	1,244	1,657,221	60,408	12,781	39,580	1,918	2,169,352	13.2
CP1	16,506,006	13	-4,468	-9,351	72	260	1,335	-4,981	681	-4,004	9	-20,434	13.0
CP2	16,530,484	16	-6,930	-17,293	-227	-235	13,011	-13,274	1,365	-7,778	21	-31,322	12.9
CP3	16,490,067	8	-7,052	-20,026	22	-506	24,700	-13,886	1,601	-9,233	-13	-24,387	13.0
CP4	16,680,674	31	-3,817	-9,437	115	-1,178	24,473	-51,876	1,598	-25,165	376	-64,881	12.6
CP4A	16,605,665	24	-7,228	-17,421	-133	-986	25,362	-38,438	1,887	-17,463	192	-54,205	12.7
CP5	16,509,915	10	-7,789	-20,075	64	41	14,598	-13,820	-475	-10,547	-17	-38,010	12.9

Notes:

Late fall-run Chinook salmon are used as a surrogate for steelhead

[1] The potential number of smolt equivalent is based on the spawning population of 13,697 adults, using the formula:
Immature Smolt Equivalent Mortality = Mortality * % Survival $_{\text{(eggs to fry)}}$ * % Survival $_{\text{(fry to presmolts)}}$ * % Survival $_{\text{(presmolts to immature smolts)}}$

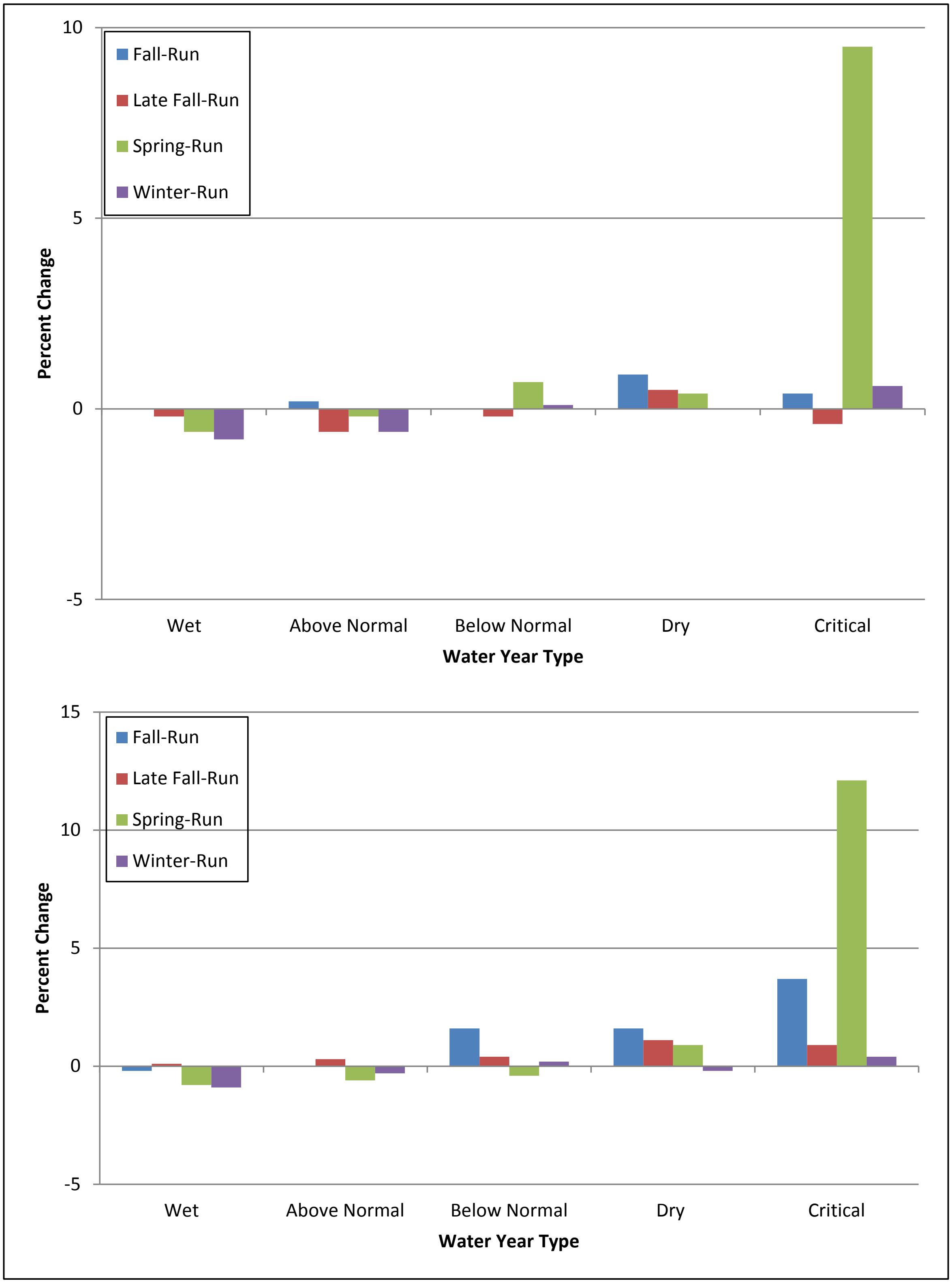
[2] Values in these two columns do not constitute a difference from the baseline condition.

Key:

CP = Comprehsensive Plan

All Chinook Runs Combined

Raising Shasta Dam by 6.5 feet under CP1, in conjunction with spillway modifications, would result in an increase in full pool depth of 8.5 feet and an additional 256,000 acre-feet of storage capacity in Shasta Reservoir. The additional storage created by the dam raise would be used to improve the ability to meet water temperature objectives and habitat requirements for anadromous fish during drought years (see Figure 11-13). Under the 2030 conditions, overall production for all four runs of Chinook salmon combined would increase by over 61,000 immature smolts migrating below RDPP. Under the 2005 conditions, overall production for all four runs of Chinook salmon combined would increase by almost 344,000 immature smolts migrating below RDPP.



Note: Changes in outmigrating Chinook salmon simulated using SALMOD; Water Year Types based on the Sacramento Valley Water Year Hydrologic Classification

Figure 11-13. Percent Change in Production of Chinook Salmon for CP1 Compared to the No-Action Alternative (top) and Existing Conditions (bottom)

Impact Aqua-13 (CP1): Changes in Flow and Water Temperatures in the Upper Sacramento River Resulting from Project Operation – Steelhead, Green Sturgeon, Sacramento Splittail, American Shad, and Striped Bass Project operation generally would result in slightly improved flow and water temperature conditions in the upper Sacramento River for steelhead, green sturgeon, Sacramento splittail, American shad, and striped bass. This impact would be less than significant.

Flow-Related Effects Under CP1, monthly mean flows at all modeling locations along the upper Sacramento River (below Shasta Dam, below Keswick Dam, above Bend Bridge, and above RBPP) would be essentially equivalent to (less than 2-percent difference from) flows under the Existing Condition and No-Action Alternative simulated for all months. (See the Modeling Appendix for complete modeling results.)

Potential flow-related effects of CP1 on fish species of management concern in the upper Sacramento River would be minimal. During most years, releases from Shasta Lake would be unchanged. During average and wet years, river flows would decrease slightly from December through February in some years because of the use of increased capacity within Shasta Lake, usually after an extended dry period. Also, flows (and stages) would increase slightly from June through October in most years. Although small, increased flow would be most pronounced during dry periods as a result of increased releases from Shasta Dam for water supply reliability purposes. However, few to no changes would occur in water flows during dry years in winter and spring.

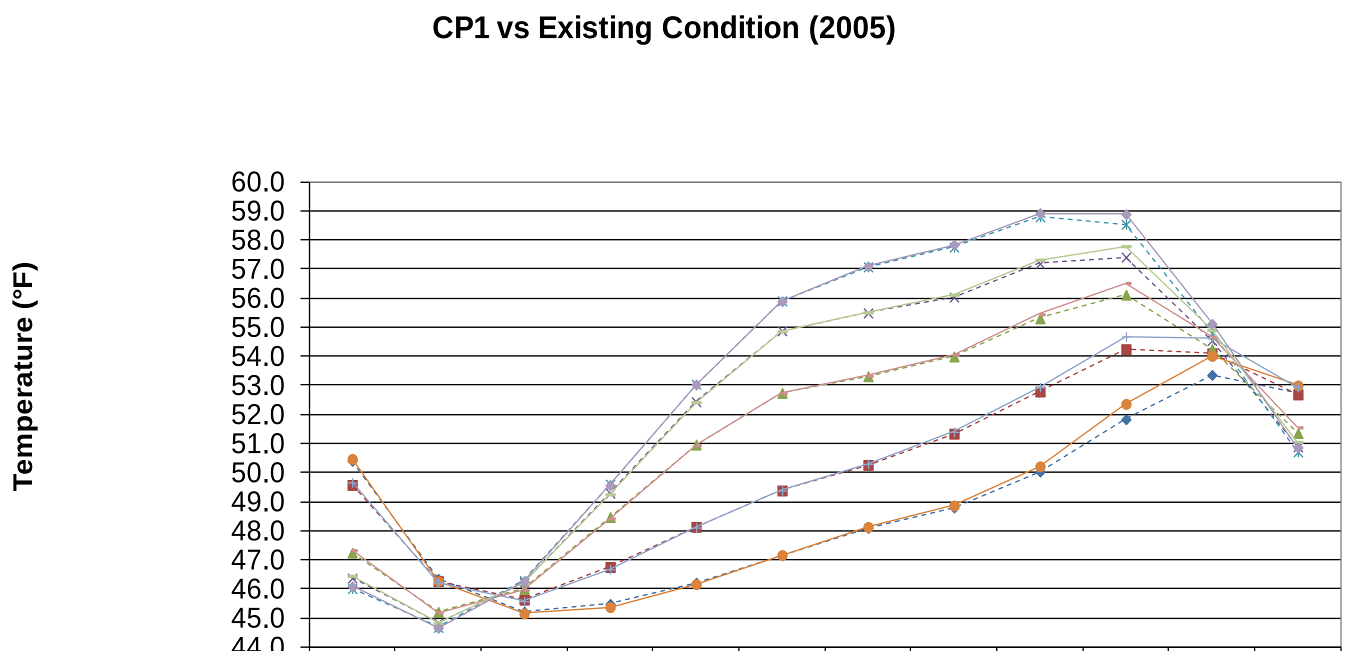
The average changes in monthly mean flow would be reductions or increases of several percent, although the changes in monthly mean flow would be greater in some years. Nonetheless, differences generally would be small (less than 2 percent). Potential changes in flows and stages would diminish downstream from RBPP because of increased effects from tributary inflows, diversions, and flood bypasses.

Changes in monthly mean flows under CP1 relative to the Existing Condition and No-Action Alternative would have no discernible effects on steelhead, green sturgeon, Sacramento splittail, American shad, or striped bass in the upper Sacramento River. Functional flows for migration, attraction, spawning, egg incubation, and rearing/emigration for these species would be unchanged. Therefore, flow-related impacts on these species would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Water Temperature–Related Effects Under CP1, monthly mean water temperatures at all modeling locations along the upper Sacramento River (below Shasta Dam, below Keswick Dam, Balls Ferry, above Bend Bridge, and above RBPP) would be the same as, or fractionally less than, water temperatures under the Existing Condition and No-Action Alternative conditions simulated for all months (Figures 11-14 and 11-15). See the Modeling Appendix for complete modeling results.

As discussed above, the modeling simulations may not fully account for real-time management of the cold-water pool and TCD (through the SRTTG) to achieve maximum cold-water benefits. Therefore, the modeled changes in water temperature (i.e., small benefits) are likely conservative and understated to some degree. Potential water temperature–related effects of CP1 on fish species of management concern in the upper Sacramento River would be minimal.

The slightly cooler monthly mean water temperatures under CP1 relative to the Existing Condition and the No-Action Alternative would have very small effects on steelhead, green sturgeon, Sacramento splittail, American shad, and striped bass in the upper Sacramento River. Mean monthly water temperatures would not rise above important thermal tolerances for the species life stages relevant to the upper Sacramento River. Therefore, water temperature–related impacts on these fish species would be less than significant. Mitigation for this impact is not needed, and thus not proposed.



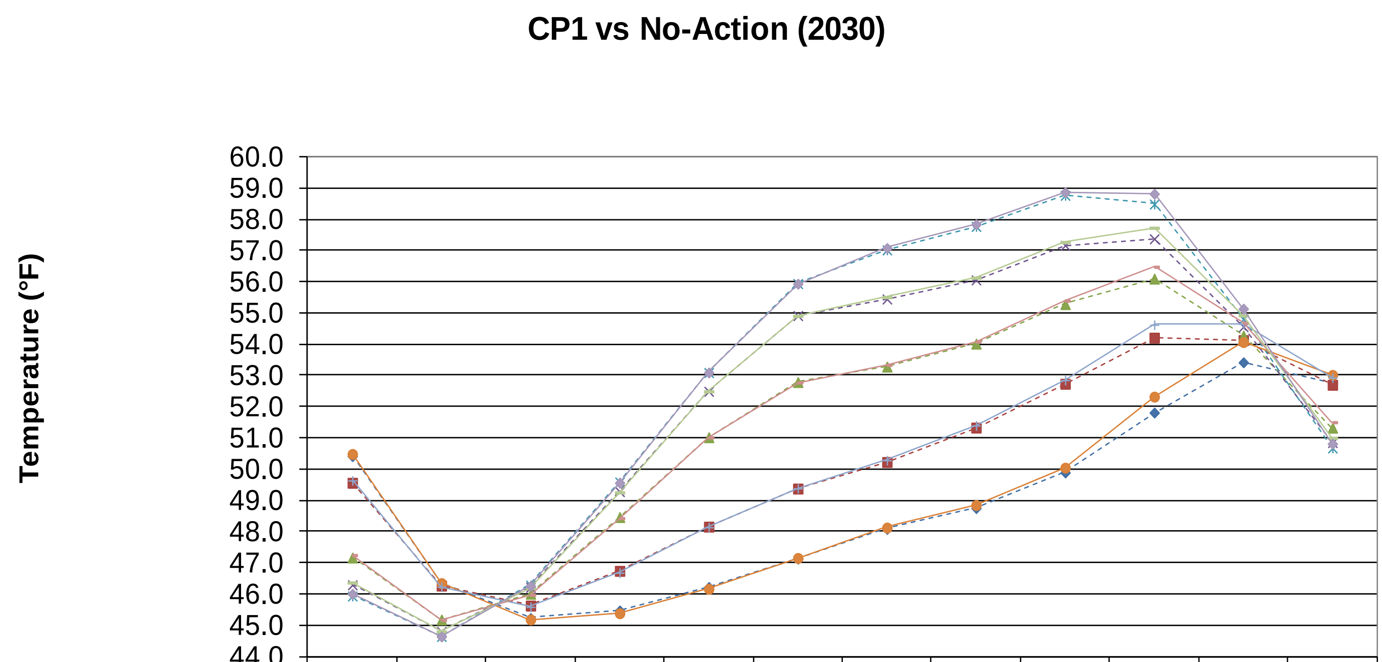
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CP1 Below Shasta	50.4	46.3	45.2	45.5	46.2	47.2	48.1	48.8	50.0	51.8	53.4	52.7
CP1 Below Keswick	49.6	46.3	45.6	46.8	48.1	49.4	50.3	51.3	52.8	54.2	54.1	52.7
CP1 Balls Ferry	47.2	45.2	46.0	48.5	51.0	52.7	53.3	54.0	55.3	56.1	54.3	51.4
CP1 Bend Bridge	46.4	44.8	46.2	49.3	52.4	54.9	55.5	56.0	57.2	57.4	54.5	50.9
CP1 RBPP	46.0	44.7	46.3	49.6	53.0	55.9	57.1	57.8	58.8	58.5	54.8	50.7
EC Below Shasta	50.5	46.3	45.2	45.4	46.2	47.2	48.1	48.9	50.2	52.4	54.0	53.0
EC Below Keswick	49.7	46.2	45.6	46.7	48.1	49.4	50.3	51.4	52.9	54.7	54.6	52.9
EC Balls Ferry	47.3	45.2	46.0	48.4	50.9	52.7	53.3	54.1	55.4	56.5	54.7	51.6
EC Bend Bridge	46.5	44.8	46.2	49.3	52.4	54.9	55.5	56.1	57.3	57.8	54.9	51.1
EC RBPP	46.1	44.7	46.3	49.6	53.0	55.9	57.1	57.8	58.9	58.9	55.1	50.9

Key:

°F = degrees Fahrenheit EC = Existing Condition

CP = Comprehensive Plan RBPP = Red Bluff Pumping Plant

Figure 11-14. Changes in Mean Monthly Water Temperature at Modeled Locations in the Sacramento River Within the Primary Study Area (CP1 Versus Existing Condition)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CP1 Below Shasta	50.4	46.3	45.2	45.5	46.2	47.1	48.1	48.8	49.9	51.8	53.4	52.8
CP1 Below Keswick	49.6	46.3	45.6	46.7	48.2	49.4	50.2	51.3	52.7	54.2	54.1	52.7
CP1 Balls Ferry	47.2	45.2	46.0	48.5	51.0	52.8	53.3	54.0	55.3	56.1	54.3	51.3
CP1 Bend Bridge	46.3	44.8	46.2	49.3	52.5	54.9	55.4	56.1	57.2	57.4	54.6	50.9
CP1 RBPP	45.9	44.6	46.3	49.6	53.1	55.9	57.0	57.8	58.8	58.5	54.8	50.7
NA Below Shasta	50.5	46.3	45.2	45.4	46.2	47.2	48.1	48.9	50.0	52.3	54.1	53.0
NA Below Keswick	49.6	46.2	45.6	46.7	48.1	49.4	50.3	51.4	52.9	54.6	54.6	52.9
NA Balls Ferry	47.3	45.2	46.0	48.4	51.0	52.8	53.3	54.1	55.4	56.5	54.7	51.5
NA Bend Bridge	46.4	44.8	46.2	49.3	52.5	54.9	55.5	56.1	57.3	57.7	54.9	51.0
NA RBPP	46.0	44.6	46.3	49.6	53.1	55.9	57.1	57.8	58.9	58.8	55.1	50.8

Key:
°F = degrees Fahrenheit NA = No-Action Alternative
CP = Comprehensive Plan RBPP = Red Bluff Pumping Plant

Figure 11-15. Changes in Mean Monthly Water Temperature at Modeled Locations in the Sacramento River Within the Primary Study Area (CP1 Versus No-Action Alternative)

Impact Aqua-14 (CP1): Reduction in Ecologically Important Geomorphic Processes in the Upper Sacramento River Resulting from Reduced Frequency and Magnitude of Intermediate to High Flows Project operations could cause a reduction in the magnitude, duration, and frequency of intermediate to large flows both in the upper Sacramento River and in the lowermost (confluence) areas of tributaries. Such flows are necessary for channel formation and maintenance, meander migration, and the creation of seasonally inundated floodplains. These geomorphic processes are ecologically important because they are needed to maintain important aquatic habitat functions and values for fish and macroinvertebrate communities. This impact would be potentially significant.

Sediment transport, deposition, and scour regulate the formation of key habitat features such as point bars, gravel deposits, and shaded riverine aquatic (SRA) habitat. These processes are regulated by the magnitude, duration, and frequency of flows. Relatively large floods provide the energy required to mobilize sediment from the riverbed, produce meander migration, and create seasonally inundated floodplains. Project operations could cause a reduction in the intermediate to large flows necessary for channel formation and maintenance, meander migration, and the creation of seasonally inundated floodplains.

Channel Forming and Maintenance In undisturbed alluvial rivers, channels and bedforms develop in response to flow and sediment loading conditions that may vary by orders of magnitude within a few hours. In many cases, the frequency distribution of flow and sediment supply are such that rivers convey the greatest fraction of their sediment load at an intermediate dominant discharge, which is often close to the bankfull flow (Leopold, Wolman, and Miller 1964). Although the recurrence interval of bankfull flow varies from river to river, it is often close to 1.5 to 2 years (Leopold, Wolman, and Miller 1964). This provides a rational basis for assuming that coarse sediment is routed as bedload during the 1.5-year flood (i.e., Q1.5). Flow regulation of the Sacramento River has reduced the river's Q1.5 by 30 percent from 86,000 cfs to 61,000 cfs (Kondolf et al. 2000).

Bankfull flow may provide a good first approximation for assessing the threshold for bed mobilization; however, it does not necessarily indicate the flow levels required to maintain the health of habitats in the alluvial system. For example, it has been estimated that a naturally occurring flood with a 5- to 10-year recurrence interval may often be required for maintenance of a mobile alternating bar-pool sequence (Trush, McBain, and Leopold 2000), which is an ecologically desired condition. In the regulated flow regime of the Sacramento River, the 10-year flood has been reduced by 38 percent from 218,000 cfs to 134,000 cfs (Kondolf et al. 2000).

At many locations between Keswick Dam and RBPP, the channel is characterized by bedrock control of its base level and its banks. This implies that, compared to alluvial reaches downstream, the channel in this area has been less able to adjust hydraulic geometry (channel width and depth) in response to dam-related changes in flow. Thus, it is possible that the channel is not in balance with the current flow regime, so that typical recurrence intervals of mobilization and bedform alteration are much longer than they were before the dams reduced the magnitude of the 1.5-year and 10-year floods (i.e., Q1.5 and Q10). This implies that the bed and point bars may have become static in the post-dam era, and that only remnants of gravel from once-abundant spawning habitat in this reach remain.

The flow required for mobilization and scour of a channel bed depends in part on the grain-size distribution of the bed sediment. On the Sacramento River, the grain-size distributions of deposits between Keswick Dam and Cottonwood Creek may have increased since construction of Shasta Dam because of winnowing associated with dam-related reductions in sediment supply (Stillwater Sciences 2006). This would tend to increase the threshold for mobilization and scour of the channel bed, even as the frequency of high flows was reduced by operations of Shasta Dam. The hypothesized coarsening of the bed would thus tend to make mobilization of sediment and bedforms even less likely under the regulated flow regime in the upper Sacramento River.

Changes (reductions) in intermediate to large flows in the Sacramento River also have the potential to affect the lower reaches (confluence areas) of tributaries by reducing the mainstem river’s backwater effect on the lower reaches of the tributaries. A decrease in the frequency, duration, and intensity of intermediate to large flows on the Sacramento River, and an associated decrease in the stage elevation of the river surface, could increase the amount of downcutting in the lower reaches of the tributaries. Downcutting of the lower tributaries could result in bank erosion, channel widening, and disconnection of the channel from its floodplain, which in turn could affect riparian recruitment and succession processes.

Meander Migration Suitable spawning habitat on the mainstem Sacramento River currently extends from Keswick Dam to Princeton. Since 1945, Shasta (and later Keswick) Dam has altered mainstem flow and sediment supply, and has thus affected the quantity and grain-size distributions of gravel in the channel bed. This in turn has affected the extent and quality of salmonid spawning habitat. The expected evolution of spawning gravel in the Sacramento River can be summarized in the following three working hypotheses (Stillwater Sciences 2006):

1. Bed coarsening in the upper Sacramento River has occurred and is continuing. As a result, spawning habitat has been progressively reduced in the reach between Keswick Dam and Anderson Bridge, despite the effects of regular gravel augmentation.

2. Bed coarsening has progressed downstream since 1980 and has now reduced the area of spawning habitat between Anderson Bridge and Cottonwood Creek.

3. The concentration of fine sediment below the surface has appeared to remain suitably low between Keswick Dam and Cottonwood Creek. It may have become higher in downstream reaches, however, because of a combination of factors: dam-related reductions in large flows, high sediment supply from Cottonwood Creek, and local hydraulic conditions (i.e., a break in slope) that promote local deposition. Thus, successful spawning of Chinook salmon in reaches below Cottonwood Creek may have been compromised.

The success of anadromous salmonids depends strongly on gravel dynamics in the mainstem river. However, other fish species of primary management concern rely much more heavily on the dynamics of meander migration, which affects the quality and availability of near- and off-channel habitat such as SRA.

SRA habitat is defined as the nearshore aquatic habitat occurring at the interface between a river and adjacent woody riparian habitat. SRA habitat is composed of vegetation and instream tree and shrub debris that provides important fish habitat. The principal attributes of this cover type are (1) an adjacent bank composed of natural, eroding substrates supporting riparian vegetation that either overhang or protrude into the water; and (2) water that contains variable amounts of woody debris, such as leaves, logs, branches, and roots, and has variable depths, velocities, and currents.

Riparian habitat provides structure (through SRA habitat) and food for fish species. Shade decreases water temperatures, while low overhanging branches can provide sources of food by attracting terrestrial insects. As riparian areas mature and banks erode, the vegetation sloughs off into the rivers, creating structurally complex habitat consisting of instream woody material that furnishes refugia from predators, alters water velocities, and provides habitat for aquatic invertebrates. For these reasons, many fish species are attracted to SRA habitat.

On the upper Sacramento River, actively migrating reaches alternate with stable reaches, which migrate slowly or not at all because they are confined by erosion-resistant geologic deposits or revetment placed to protect adjacent land uses. Meander migration and bank erosion occur by progressive channel migration and episodic meander-bend cutoff. Over decadal timescales, cutoffs generally affect less than 10 percent of the actively migrating length of the Sacramento River. Even so, cutoffs can account for well over 20 percent of the integrated lateral channel change, because they affect relatively large areas when they do occur (Stillwater Sciences 2006).

Chute cutoff and progressive migration interact to produce a characteristic pattern of planform development over time. Individual bends evolve greater sinuosity and curvature via progressive channel migration. Cutoffs reduce sinuosity when it exceeds a local threshold for the initiation of cutoff processes. This should produce measurable changes in local geomorphology over time. Averaged over larger timescales, however, changes in morphology in one reach should be balanced by changes in morphology in others. Thus, in the absence of human modifications, the overall pattern of planform geometry for migrating portions of rivers should approach a state of dynamic equilibrium. Studies indicate that the sinuosity of cutoff bends on the Sacramento River is decreasing over time (Stillwater Sciences 2006). This suggests that the Sacramento River is not in a state of dynamic equilibrium. The fact that cutoff migration has increased in frequency and is increasingly dominated by partial cutoffs (which affect smaller areas than complete cutoffs) provides further evidence that nonequilibrium conditions may prevail.

Process-based interpretations suggest that potential project-related changes in flow (i.e., reductions in peak flow and overbank discharge) could tend to reduce the frequency of these important geomorphic processes. This would generally be accompanied by a reduction in average sinuosity; however, observations from the Sacramento River indicate that the overall number of channel cutoffs has nevertheless increased. This supports the hypothesis that the erodibility of banks and floodplains has increased (thus enhancing the likelihood of cutoff) because of the effects of agricultural clearing of riparian forests on floodplains (Micheli, Kirchner, and Larsen 2004).

Floodplain Inundation Inundation of floodplains reduces the magnitude (i.e., peak volume) of flood flows and promotes exchange of nutrients, organisms, sediment, and energy between the terrestrial and aquatic systems. Flood pulses contribute to high rates of primary productivity in functioning floodplain systems (Junk, Bayley, and Sparks 1989). On the Sacramento River, floodplains provide important winter and spring spawning and rearing habitats for native fish, such as Sacramento splittail and Chinook salmon (Moyle et al. 2004, Sommer et al. 2001).

Typically, the floodplain immediately adjacent to the river is maintained at an elevation equal to the bankfull stage of the channel, such that discharge magnitudes greater than the bankfull flow inundate the adjacent floodplains (Leopold, Wolman, and Miller 1964). Because bankfull flow typically has a recurrence interval of 1.5 to 2 years (Q1.5–2) on alluvial rivers, flow magnitudes greater than the 1.5-year (Q1.5) flow event are often assumed to initiate floodplain inundation.

These effects would likely occur throughout the upper Sacramento River portion of the primary study area. Reductions in the magnitude of high flows would likely be sufficient to reduce ecologically important processes along the upper Sacramento River. Therefore, this impact would be potentially significant. Mitigation for this impact is proposed in Section 11.3.4, “Mitigation Measures.”

Lower Sacramento River and Tributaries, Delta, and Trinity River

Impact Aqua-15 (CP1): Changes in Flow and Water Temperatures in the Lower Sacramento River and Tributaries and Trinity River Resulting from Project Operation – Fish Species of Primary Management Concern Project operation would result in no discernible change in monthly mean flows or water temperature conditions in the lower Sacramento River. However, predicted changes in flows in the Feather, American, and Trinity rivers could result in adverse effects on Chinook salmon, steelhead, Coho salmon, green sturgeon, Sacramento splittail, American shad, and striped bass. This impact would be potentially significant.

As described below, monthly mean flows at various modeling locations on the lower Sacramento River and tributaries under CP1 were compared with monthly mean flows simulated for the Existing Condition and No-Action Alternative conditions. Modeling for the lower American River occurred at Verona and Freeport; for the lower Feather River, modeling occurred below Thermalito Afterbay, and American River modeling occurred near the H Street Bridge in Sacramento. Modeling also occurred on the Trinity River. See the Modeling Appendix for complete CalSim-II modeling results.

Lower Sacramento River Under CP1, monthly mean flows at the lower Sacramento River modeling locations would be comparable to flows under the Existing Condition and No-Action Alternative conditions simulated for all months. Differences in modeled monthly mean flow were generally small (less than 2 percent) and within the existing range of variability. Potential changes in flows would diminish rapidly downstream from RBPP because of increased effects from tributary inflows, diversions, and flood bypasses. Thus, potential flow-related effects of CP1 on fish species of management concern in the lower Sacramento River would be minimal.

Mean monthly mean flows at all modeling locations on the lower Feather River and American River under CP1 would be essentially equivalent to (less than 2-percent difference from) flows under the Existing Condition and No-Action Alternative conditions simulated for all months. Potential changes in flows are diminished in these areas because of operation of upstream CVP and SWP reservoirs (i.e., Lake Oroville and Folsom Lake) and increasing effects from tributary inflows, diversions, and flood bypasses. Potential flow-related effects of CP1 on fish species of management concern in the Feather River and American River would be minimal and within the existing range of variability. Potential changes in water temperatures in the lower Sacramento River caused by small changes in releases would diminish rapidly downstream because of the increasing effects of inflows, atmospheric influences, and groundwater. Therefore, flow- and water temperature–related impacts on fish species in the lower Sacramento River would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

The effects of altered flow regimes resulting from implementation of CP1 are unlikely to extend into the lower Sacramento River downstream from Verona and into the Delta because the Central Valley's reservoirs and diversions are managed as a single integrated system (consisting of the CVP and SWP). The operational requirements, including the 2008 USFWS BO and the 2009 NMFS BO, have been designed to maintain standards for flow to the lower Sacramento River and Delta. CVP and SWP operations must be consistent with these ESA BOs. Thus, implementation of CP1 would likely not alter flow to the Delta or water temperatures in the lower Sacramento River and its primary tributaries to a degree sufficient to affect Chinook salmon, steelhead, green sturgeon, Sacramento splittail, American shad, or striped bass relative to the Existing Condition and No-Action Alternative. Functional flows for fish migration, attraction, spawning, egg incubation, and rearing/emigration for all these fish species would be unchanged. Therefore, flow- and water temperature–related effects on these fish species in the lower Sacramento River and tributaries would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Lower Feather River and American River Under CP1, monthly mean flows at modeling locations on the lower Feather River and American River would be essentially equivalent to (less than 2-percent difference from) flows under the Existing Condition and No-Action Alternative conditions simulated for most months. However, simulations for several months within the modeling record show substantial changes to flows in tributaries. Potential changes in flows in these areas could be reduced by real-time operations to meet existing rules and operation of upstream CVP and SWP reservoirs (Lake Oroville and Folsom Lake). Nevertheless, based on predicted changes in flow and associated flow-habitat relationships (including water temperature) for fish, potential flow-related impacts on species of management concern in the American and Feather rivers would be potentially significant. Mitigation for this impact is proposed in Section 11.3.4, "Mitigation Measures."

Trinity River As with the lower Feather River and American River, monthly mean flows at all modeling locations within the Trinity River under CP1 would be essentially equivalent to (less than 2-percent difference from) flows under the Existing Condition and No-Action Alternative simulated for most months. Based on predicted changes in flow and associated flow-habitat relationships for fish, potential flow-related impacts on species of management concern in the Trinity River would be potentially significant. Mitigation for this impact is proposed in Section 11.3.4, "Mitigation Measures."

Impact Aqua-16 (CP1): Reduction in Ecologically Important Geomorphic Processes in the Lower Sacramento River Resulting from Reduced Frequency and Magnitude of Intermediate to High Flows Project operation could cause a reduction in intermediate to large flows both in the lower Sacramento River and in the lowermost (confluence) areas of its tributaries. Such flows are necessary for channel forming and maintenance, meander migration, and the creation of seasonally inundated floodplains. These geomorphic processes are ecologically important because they are needed to maintain important aquatic habitat functions and values for fish and macroinvertebrate communities. This impact would be potentially significant.

As discussed under Impact Aqua-14 (CP1), sediment transport, deposition, and scour regulate the formation of key habitat features such as point bars, gravel deposits, and SRA habitat. These processes are regulated by the magnitude, duration, and frequency of flows. Relatively large flows provide the energy required to mobilize sediment from the riverbed, produce meander migration, and create seasonally inundated floodplains. Project operations could cause a reduction in the intermediate to large flows necessary for channel forming and maintenance, meander migration, and the creation of seasonally inundated floodplains (including floodplain bypasses) along the lower Sacramento River.

There is substantially less bedrock control in the middle reach of the Sacramento River (between RBPP and Colusa) than along the Sacramento River between Keswick Dam and the RBPP. Consequently, sediment transport and meander migration processes are more pronounced in this more alluvial reach. This is supported by widespread evidence of frequent lateral migration in the middle reach of the Sacramento River (e.g., Micheli, Kirchner, and Larsen 2004). This implies that the middle reach of the Sacramento River experience much more frequent bed and bar mobilization than the Sacramento River between Keswick Dam and RBPP.

As discussed under Impact Aqua-14 (CP1), changes (reductions) in intermediate to large flows in the Sacramento River have the potential to affect the lower reaches (confluence areas) of tributaries by reducing the mainstem river's backwater effect on the lower reaches of the tributaries. A decrease in the frequency, duration, and intensity of intermediate to large flows on the Sacramento River, and an associated decrease in the stage elevation of the river surface, could increase the amount of downcutting in the lower reaches of the tributaries. Downcutting of the lower tributaries could result in bank erosion, channel widening, and disconnection of the channel from its floodplain, which in turn could affect riparian recruitment and succession processes.

Reaches of the Sacramento River differ in the extent of floodplain inundation. Most of the upper Sacramento River between Keswick Dam and RBPP is also bounded by high banks and terraces, limiting the opportunity for floodplain inundation in this reach. Also along the upper reaches of the lower Sacramento River, between Chico Landing and Colusa, the river is bounded by levees that provide flood protection for cities and agricultural areas. However, the levees of this reach of the Sacramento River are mostly set back from the mainstem channel, so that substantial flooding can occur within the river corridor. In the lower Sacramento River between RBPP and Chico Landing, the mainstem channel is flanked by broad floodplains. Evidence of ongoing sediment deposition of these areas testifies to continued inundation in floodplains in this reach (Buer 1994).

An important attribute of the middle and lower reaches of the Sacramento River is the presence of floodplain bypasses (e.g., Butte Basin, Sutter Bypass, and Yolo Bypass). In winter and spring, agricultural fields and wetland habitats throughout the floodplain bypasses often flood during high flows and are used by Sacramento splittail for spawning and rearing, and by Chinook salmon and steelhead for rearing (Sommer et al. 2001, 2003). Numerous studies have shown that shallow water and dense vegetation in these areas provide highly productive rearing areas for numerous species, including Chinook salmon and splittail. Seasonally flooded habitat provides rearing habitat for Chinook salmon and spawning, rearing, and foraging habitat for splittail (Sommer et al. 1997, 2001, 2002; Baxter et al. 1996; USACE 1999). Floodplain habitat offers protection from large piscivorous fish such as striped bass. The temporary nature of the flooded habitat and the protection offered by shallow water and dense vegetative cover serve to exclude predatory fish.

The productivity of floodplains is generally related to the frequency, timing, water depths, velocities, vegetation, water quality, and duration of inundation relative to the life history and habitat requirements of fish species. Physical conditions (e.g., type and extent of vegetation, soil conditions, and drainage patterns) may also contribute to habitat quality. Flooded vegetation provides an abundant source of food, consisting of detrital material, insect larvae, crustaceans, and other invertebrates. Juvenile Chinook salmon and splittail apparently forage among a variety of vegetation types, such as trees, brush, and herbaceous vegetation; however, the relative importance of these vegetation types, alone or in combination, is unknown.

Juvenile Chinook salmon that rear in seasonally flooded habitat have higher survival and growth rates than juveniles that remain in the main river channel to rear (USACE 1999, Sommer et al. 2001). The increased growth rate may be related to the higher water temperatures in the shallow water in this habitat. It also may be related to the higher associated rate of production of invertebrates, which are a substantial source of food for rearing juveniles, and of the grasses that support the invertebrates. Increases in the area available to juveniles could also reduce competition for food and space, and could reduce the likelihood of encounters with predators (Sommer et al. 2001). In addition, juvenile Chinook salmon that grow faster are likely to migrate downstream sooner, which helps to reduce the risks of predation and competition in freshwater systems.

In summary, implementation of CP1 could cause a further reduction in the magnitude, duration, and frequency of intermediate to large flows relative to the Existing Condition and No-Action Alternative. Overall, the project would increase the existing, ongoing effects on geomorphic processes resulting from operation of Shasta Dam that are necessary for channel forming and maintenance, meander migration, the creation of seasonally inundated floodplains, and the inundation of floodplain bypasses. These effects would likely occur along the upper reaches of the lower Sacramento River. Reductions in the magnitude of high flows would likely be sufficient to reduce ecologically important processes along the upper Sacramento River and its floodplain bypasses. This impact would be potentially significant. Mitigation for this impact is proposed in Section 11.3.4, "Mitigation Measures."

Impact Aqua-17 (CP1): Effects to Delta Fisheries Resulting from Changes to Delta Outflow Based on the results of hydrologic modeling comparing Delta outflow under the No-Action Alternative, Existing Condition, and CP1, CP1 would result in changes to average monthly Delta outflow of less than 5 percent in all year types (with the exception of November of above-normal water years under 2005 conditions). Delta outflow serves as a surrogate metric for a variety of habitat conditions within the Delta that directly, or indirectly, affects fish and other aquatic resources.

This impact on Delta fisheries and hydrologic transport processed within the Bay-Delta would be less than significant.

Results of the comparison of Delta outflows are summarized by month and water year type in Table 11-12. Delta outflow serves as a surrogate metric for a variety of habitat conditions within the Delta that directly, or indirectly, affects fish and other aquatic resources.

The comparison includes the estimated average monthly outflow under the Existing Condition, No-Action Alternative, and CP1, and the percentage change between base flows and CP1 operations. Results of the analysis (Table 11-12) show that Delta outflows would be slightly lower under many of the CP1 operations, and slightly higher than basis-of-comparison conditions depending on month and water year type. However, only one of the simulated changes was greater than 5 percent (November of above-normal water years under 2005 conditions). Based on results of this analysis, CP1 would result in a less-than-significant impact on Delta fisheries as a consequence of changes in Delta outflow. Mitigation for this impact is not needed, and thus not proposed.

Table 11-12. Delta Outflow Under the Existing Condition, No-Action Alternative, and CP1

		Existing Condition	CP1 (2005)		No-Action Alternative	CP1 (2030)	
Month	**Water Year**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**
January	Average	42,078	42,002	0	42,169	41,971	0
	W	84,136	83,964	0	84,037	83,638	0
	AN	47,221	47,120	0	46,984	46,914	0
	BN	21,610	21,622	0	21,990	22,023	0
	D	14,166	14,038	-1	14,452	14,302	-1
	C	11,560	11,687	1	11,757	11,525	-2
February	Average	51,618	51,526	0	51,430	51,274	0
	W	95,261	95,104	0	94,634	94,399	0
	AN	60,080	59,779	-1	60,278	59,738	-1
	BN	35,892	35,976	0	35,665	35,755	0
	D	20,978	20,924	0	20,946	20,869	0
	C	12,902	12,898	0	13,088	13,081	0
March	Average	42,722	42,651	0	42,585	42,582	0
	W	78,448	78,500	0	78,376	78,430	0
	AN	53,486	53,121	-1	53,139	53,014	0
	BN	23,102	22,906	-1	22,980	22,892	0
	D	19,763	19,848	0	19,559	19,621	0
	C	11,881	11,747	-1	11,893	11,892	0
April	Average	30,227	30,236	0	30,743	30,757	0
	W	54,640	54,650	0	55,460	55,459	0
	AN	32,141	32,127	0	32,971	32,976	0
	BN	21,773	21,820	0	22,511	22,523	0
	D	14,347	14,343	0	14,538	14,559	0
	C	9,100	9,108	0	8,873	8,918	0
May	Average	22,619	22,567	0	22,249	22,196	0
	W	41,184	41,165	0	40,543	40,522	0
	AN	24,296	24,201	0	24,454	24,229	-1
	BN	16,346	16,144	-1	15,989	15,809	-1
	D	10,554	10,580	0	10,116	10,170	1
	C	6,132	6,110	0	5,910	5,947	1
June	Average	12,829	12,776	0	12,660	12,620	0
	W	23,473	23,473	0	23,015	23,016	0
	AN	12,080	11,746	-3	11,799	11,635	-1
	BN	7,995	8,019	0	7,991	7,920	-1
	D	6,691	6,656	-1	6,764	6,743	0
	C	5,361	5,361	0	5,378	5,376	0
July	Average	7,864	7,864	0	7,864	7,869	0
	W	11,230	11,237	0	11,181	11,185	0
	AN	9,562	9,530	0	9,407	9,400	0
	BN	7,117	7,118	0	7,225	7,274	1
	D	5,005	5,006	0	5,052	5,042	0
	C	4,034	4,050	0	4,098	4,088	0

Table 11-12. Delta Outflow Under the Existing Condition, No-Action Alternative, and CP1 (contd.)

		Existing Condition	CP1 (2005)		No-Action Alternative	CP1 (2030)	
Month	**Water Year**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**
August	Average	4,322	4,337	0	4,335	4,349	0
	W	5,302	5,319	0	5,097	5,093	0
	AN	4,000	4,000	0	4,000	4,000	0
	BN	4,000	4,000	0	4,002	4,000	0
	D	3,906	3,896	0	4,142	4,189	1
	C	3,520	3,604	2	3,699	3,736	1
September	Average	9,841	9,840	0	9,844	9,858	0
	W	19,695	19,670	0	19,702	19,707	0
	AN	11,784	11,771	0	11,849	11,836	0
	BN	3,876	3,886	0	3,913	3,926	0
	D	3,508	3,516	0	3,442	3,496	2
	C	3,008	3,040	1	3,005	3,005	0
October	Average	6,067	6,063	0	6,000	6,003	0
	W	7,926	7,894	0	7,633	7,596	0
	AN	5,309	5,360	1	5,476	5,550	1
	BN	5,479	5,514	1	5,502	5,504	0
	D	5,228	5,234	0	5,236	5,238	0
	C	4,741	4,684	-1	4,714	4,732	0
November	Average	11,706	11,549	-1	11,675	11,525	-1
	W	17,717	17,621	-1	17,715	17,484	-1
	AN	12,667	11,852	-6	12,491	12,084	-3
	BN	8,543	8,513	0	8,686	8,579	-1
	D	8,482	8,468	0	8,414	8,414	0
	C	6,250	6,256	0	6,150	6,156	0
December	Average	21,755	21,601	-1	21,745	21,592	-1
	W	44,974	44,556	-1	44,661	44,182	-1
	AN	18,581	18,667	0	18,562	18,513	0
	BN	12,219	12,135	-1	12,326	12,402	1
	D	8,531	8,453	-1	8,803	8,710	-1
	C	5,580	5,567	0	5,677	5,774	2

Note:
A negative percentage change reflects a reduction in Delta outflow
Key:
AN = above-normal
BN = below-normal
C = critical
cfs = cubic feet per second
CP = Comprehensive Plan
D = dry
W = wet

Impact Aqua-18 (CP1): Effects to Delta Fisheries Resulting from Changes to Delta Inflow Based on the results of hydrologic modeling comparing Delta inflow under CP1 to the Existing Condition and No-Action Alternative, CP1 would result in changes to average monthly Delta inflow of less than 5 percent in all year types. This impact on Delta fisheries and hydrologic transport processes within the Bay-Delta would be less than significant.

Changes in upstream reservoir storage have the potential to affect Delta inflow. Delta inflow may affect hydrologic conditions within Delta channels, hydraulic residence times, salinity gradients, and the transport and movement of various life stages of fish, invertebrates, phytoplankton, and nutrients into and through the Delta. Delta inflow serves as a surrogate metric for a variety of habitat conditions within the Delta that directly, or indirectly, affects fish and other aquatic resources.

Results of the comparison of Delta inflows between the Existing Condition, No-Action Alternative, and CP1 are summarized by month and water year type in Table 11-13. The comparison includes the estimated average monthly inflow under the 2005 and 2030 conditions, the average monthly Delta inflow under CP1, and the percent change in flows between the Existing Condition or No-Action Alternative and CP1. Delta inflows would be slightly lower under many of the CP1 operations and slightly higher than basis-of-comparison conditions, depending on month and water year type. The difference in simulated average monthly Delta inflow between CP1 and the Existing Condition and the No-Action Alternative did not exceed 5 percent. Based on the results of this analysis, CP1 would have a less-than-significant effect on Delta fisheries and hydrologic transport processes within the Bay-Delta as a consequence of changes in Delta inflow. Mitigation for this impact is not needed, and thus not proposed.

Table 11-13. Delta Inflow Under the Existing Condition, No-Action Alternative, and CP1

		Existing Condition	CP1 (2005)		No-Action Alternative	CP1 (2030)	
Month	**Water Year**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**
January	Average	47,426	47,352	0	47,457	47,275	0
	W	89,431	89,259	0	89,328	88,930	0
	AN	51,611	51,501	0	51,267	51,100	0
	BN	27,269	27,281	0	27,576	27,609	0
	D	20,125	20,017	-1	20,371	20,221	-1
	C	16,699	16,820	1	16,749	16,724	0
February	Average	57,835	57,703	0	57,623	57,478	0
	W	103,140	102,976	0	102,606	102,393	0
	AN	65,379	64,882	-1	65,574	65,008	-1
	BN	41,782	41,832	0	41,374	41,419	0
	D	26,530	26,459	0	26,431	26,356	0
	C	17,818	17,813	0	17,958	18,054	1
March	Average	49,829	49,786	0	49,713	49,699	0
	W	87,688	87,728	0	87,703	87,782	0
	AN	61,498	61,359	0	61,339	61,232	0
	BN	30,569	30,372	-1	30,415	30,326	0
	D	24,943	24,943	0	24,640	24,610	0
	C	15,933	15,923	0	15,896	15,891	0
April	Average	33,962	33,971	0	34,783	34,798	0
	W	58,684	58,694	0	60,017	60,020	0
	AN	35,588	35,575	0	36,738	36,745	0
	BN	25,351	25,398	0	26,403	26,414	0
	D	17,962	17,959	0	18,315	18,336	0
	C	12,817	12,822	0	12,635	12,679	0
May	Average	27,383	27,332	0	27,091	27,044	0
	W	46,973	46,955	0	46,494	46,473	0
	AN	28,466	28,372	0	28,711	28,490	-1
	BN	20,747	20,542	-1	20,427	20,247	-1
	D	14,882	14,908	0	14,534	14,591	0
	C	10,347	10,333	0	10,038	10,109	1
June	Average	22,171	22,116	0	22,090	22,068	0
	W	35,459	35,459	0	35,172	35,172	0
	AN	23,124	22,791	-1	22,776	22,612	-1
	BN	16,884	16,897	0	16,941	16,987	0
	D	14,095	14,059	0	14,337	14,312	0
	C	10,710	10,711	0	10,694	10,694	0

Table 11-13. Delta Inflow Under the Existing Condition, No-Action Alternative, and CP1 (contd.)

		Existing Condition	CP1 (2005)		No-Action Alternative	CP1 (2030)	
Month	**Water Year**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**
July	Average	23,099	23,111	0	22,839	22,876	0
	W	27,442	27,449	0	27,496	27,500	0
	AN	25,169	25,089	0	25,065	25,044	0
	BN	23,282	23,306	0	23,362	23,347	0
	D	20,937	20,980	0	20,082	20,160	0
	C	14,647	14,706	0	14,048	14,215	1
August	Average	17,147	17,180	0	17,026	17,068	0
	W	20,235	20,257	0	20,154	20,150	0
	AN	18,784	18,760	0	18,927	18,935	0
	BN	18,274	18,272	0	18,297	18,231	0
	D	15,066	15,274	1	14,371	14,580	1
	C	10,626	10,517	-1	10,850	10,897	0
September	Average	20,946	21,049	0	21,145	21,292	1
	W	31,918	31,920	0	32,428	32,431	0
	AN	23,912	23,930	0	24,747	24,856	0
	BN	16,518	16,546	0	16,563	16,569	0
	D	14,440	14,703	2	14,233	14,683	3
	C	9,130	9,386	3	8,809	9,013	2
October	Average	14,407	14,445	0	14,175	14,236	0
	W	17,072	17,016	0	16,558	16,596	0
	AN	13,176	13,364	1	13,223	13,359	1
	BN	14,044	14,180	1	14,159	14,139	0
	D	13,133	13,243	1	12,846	12,987	1
	C	12,196	12,070	-1	11,976	11,983	0
November	Average	19,512	19,531	0	19,463	19,442	0
	W	26,429	26,521	0	26,536	26,397	0
	AN	20,269	19,726	-3	20,052	19,854	-2
	BN	16,984	17,051	0	16,980	16,884	-1
	D	15,771	15,942	1	15,705	15,909	1
	C	12,330	12,467	1	12,081	12,244	-1

Table 11-13. Delta Inflow Under the Existing Condition, No-Action Alternative, and CP1 (contd.)

		Existing Condition	CP1 (2005)		No-Action Alternative	CP1 (2030)	
Month	**Water Year**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**
December	Average	30,984	30,833	0	30,988	30,838	0
	W	53,758	53,345	-1	53,516	53,042	-1
	AN	28,431	28,505	0	28,223	28,197	0
	BN	21,958	21,855	0	22,143	22,223	0
	D	18,560	18,501	0	18,837	18,743	-1
	C	13,363	13,358	0	13,484	13,565	1

Note:
A negative percentage change reflects a reduction in Delta inflow
Key:
AN = above-normal
BN = below-normal
C = critical
cfs = cubic feet per second
CP = Comprehensive Plan
D = dry
W = wet

Impact Aqua-19 (CP1): Effects to Delta Fisheries Resulting from Changes in Sacramento River Inflow CP1 operation would result in a variable response in Sacramento River inflow, resulting in both increases and decreases in river flow above basis-of-comparison conditions depending on month and water year. Decreases in Sacramento River inflow would not equal or exceed 5 percent. This impact would be less than significant.

Flow within the Sacramento River has been identified as an important factor affecting the survival of emigrating juvenile Chinook salmon; important to the downstream transport of planktonic fish eggs and larvae such as delta and longfin smelt, striped bass and shad; and important for seasonal floodplain inundation that has been identified as important habitat for successful spawning and larval rearing by species such as Sacramento splittail and as seasonal foraging habitat for juvenile Chinook salmon and steelhead. Sacramento River flows are also important in the transport of organic material and nutrients from the upper regions of the watershed downstream into the Delta. Sacramento River inflow serves as a surrogate metric for a variety of habitat conditions within the Delta that directly, or indirectly, affects fish and other aquatic resources. A reduction in Sacramento River flow as a result of CP1, depending on the season and magnitude of change, could adversely affect habitat conditions for both resident and migratory fish species. An increase in river flow is generally considered to be beneficial for aquatic resources within the normal range of typical project operations and flood control. Very large changes in river flow could also affect sediment erosion, scour, deposition, suspended and bedload transport, and other geomorphic processes within the river and watershed.

Results of hydrologic modeling, by month and year type, for the Existing Condition, No-Action Alternative, and CP1 for Sacramento River inflow are presented in Table 11-14. Results of these analyses show a variable response in Sacramento River inflow with CP1 operations resulting in both increases and decreases in river inflow above the Existing Condition and the No-Action Alternative, depending on month and water year type. Under CP1, Sacramento River flow would not decrease by 5 percent or more. Based on these results the impact of CP1 on fish habitat and transport mechanisms within the lower Sacramento River and Delta would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 11-14. Sacramento River Inflow Under the Existing Condition, No-Action Alternative, and CP1

		Existing Condition	CP1 (2005)		No-Action Alternative	CP1 (2030)	
Month	**Water Year**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**
January	Average	31,139	31,144	0	31,167	31,136	0
	W	50,173	50,145	0	50,164	50,098	0
	AN	38,122	38,073	0	38,006	37,960	0
	BN	22,370	22,461	0	22,540	22,654	1
	D	16,980	16,924	0	17,109	17,025	0
	C	14,384	14,505	1	14,322	14,291	0
February	Average	36,608	36,567	0	36,618	36,586	0
	W	56,740	56,763	0	56,637	56,661	0
	AN	44,453	44,104	-1	44,672	44,295	-1
	BN	30,911	31,023	0	30,780	30,909	0
	D	21,249	21,178	0	21,237	21,144	0
	C	14,830	14,824	0	15,075	15,168	1
March	Average	32,396	32,367	0	32,352	32,343	0
	W	49,248	49,287	0	49,403	49,461	0
	AN	44,060	44,017	0	43,972	43,939	0
	BN	23,188	22,992	-1	23,068	22,978	0
	D	20,390	20,389	0	20,138	20,107	0
	C	12,971	12,961	0	12,942	12,938	0
April	Average	23,232	23,241	0	23,206	23,222	0
	W	37,918	37,929	0	38,019	38,024	0
	AN	26,053	26,041	0	26,039	26,048	0
	BN	17,518	17,565	0	17,439	17,450	0
	D	13,205	13,202	0	13,164	13,185	0
	C	10,295	10,300	0	10,067	10,111	0

Table 11-14. Sacramento River Inflow Under the Existing Condition, No-Action Alternative, and CP1 (contd.)

		Existing Condition	CP1 (2005)		No-Action Alternative	CP1 (2030)	
Month	**Water Year**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**
May	Average	19,417	19,369	0	19,114	19,069	0
	W	32,095	32,084	0	31,800	31,785	0
	AN	21,204	21,110	0	21,080	20,859	-1
	BN	14,530	14,326	-1	14,144	13,965	-1
	D	11,226	11,252	0	10,836	10,893	1
	C	8,148	8,134	0	7,874	7,945	1
June	Average	16,508	16,454	0	16,511	16,488	0
	W	24,092	24,092	0	23,905	23,902	0
	AN	16,598	16,264	-2	16,533	16,369	-1
	BN	13,792	13,805	0	13,822	13,868	0
	D	12,283	12,247	0	12,569	12,544	0
	C	9,492	9,493	0	9,516	9,516	0
July	Average	19,518	19,531	0	19,266	19,303	0
	W	20,071	20,077	0	20,058	20,062	0
	AN	22,070	21,990	0	21,976	21,954	0
	BN	21,232	21,256	0	21,374	21,359	0
	D	19,577	19,620	0	18,788	18,866	0
	C	13,683	13,741	0	13,100	13,267	1
August	Average	14,710	14,743	0	14,596	14,637	0
	W	16,285	16,306	0	16,189	16,185	0
	AN	16,418	16,393	0	16,561	16,569	0
	BN	16,112	16,110	0	16,170	16,104	0
	D	13,632	13,841	2	12,968	13,177	2
	C	9,570	9,461	-1	9,785	9,831	0
September	Average	18,211	18,313	1	18,417	18,563	1
	W	27,839	27,841	0	28,337	28,340	0
	AN	21,244	21,261	0	22,088	22,197	0
	BN	14,088	14,116	0	14,147	14,152	0
	D	12,522	12,779	2	12,341	12,792	4
	C	7,664	7,920	3	7,347	7,550	3
October	Average	11,309	11,389	1	11,117	11,184	1
	W	13,419	13,493	1	13,040	13,099	0
	AN	10,499	10,687	2	10,571	10,707	1
	BN	11,053	11,188	1	11,195	11,174	0
	D	10,150	10,260	1	9,830	9,972	1
	C	9,587	9,461	-1	9,333	9,340	0

Table 11-14. Sacramento River Inflow Under the Existing Condition, No-Action Alternative, and CP1 (contd.)

		Existing Condition	CP1 (2005)		No-Action Alternative	CP1 (2030)	
Month	**Water Year**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**
November	Average	15,640	15,677	0	15,605	15,629	0
	W	20,726	20,866	1	20,832	20,821	0
	AN	16,893	16,375	-3	16,666	16,506	-1
	BN	13,755	13,819	0	13,793	13,695	-1
	D	12,720	12,890	1	12,723	12,926	2
	C	9,948	10,086	1	9,653	9,815	2
December	Average	23,248	23,182	0	23,229	23,174	0
	W	37,645	37,420	-1	37,434	37,236	-1
	AN	22,604	22,694	0	22,461	22,468	0
	BN	16,930	16,961	0	17,103	17,193	1
	D	15,760	15,701	0	15,934	15,839	-1
	C	11,303	11,299	0	11,310	11,390	1

Note:
A negative percentage change reflects a reduction in Sacramento River inflow
Key:
AN = above-normal
BN = below-normal
C = critical
cfs = cubic feet per second
CP = Comprehensive Plan
D = dry
W = wet

Impact Aqua-20 (CP1): Effects to Delta Fisheries Resulting from Changes in San Joaquin River Flow at Vernalis CP1 operation would result in no discernible change in San Joaquin River flows at Vernalis, and, therefore, no effect on Delta fisheries or transport mechanisms within the lower San Joaquin River and Delta from CP1 relative to No-Action Alternative and the Existing Condition. There would be no impact.

Flow within the San Joaquin River has been identified as an important factor affecting the survival of juvenile Chinook salmon migrating downstream from the tributaries through the mainstem San Joaquin River and Delta; important to the downstream transport of planktonic fish eggs and larvae such as striped bass; and important for seasonal floodplain inundation that is considered to be important habitat for successful spawning and larval rearing by species such as Sacramento splittail and as seasonal foraging habitat for juvenile Chinook salmon. San Joaquin River flows are also important in the transport of organic material and nutrients from the upper regions of the watershed downstream into the Delta. San Joaquin River inflow serves as a surrogate metric for a variety of habitat conditions within the Delta that directly, or indirectly, affects fish and other aquatic resources. A reduction in San Joaquin River flow as a result of

CP1 operations, depending on the season and magnitude of change, could adversely affect habitat conditions for both resident and migratory fish species. An increase in river flow is generally considered to be beneficial for aquatic resources within the normal range of typical project operations and flood control. Very large changes in river flow could also affect sediment erosion, scour, deposition, suspended and bedload transport, and other geomorphic processes within the river and watershed.

Results of hydrologic modeling, by month and year type, for the Existing Condition, No-Action Alternative, and CP1 for San Joaquin River flow are summarized in Table 11-15. Results of these analyses show that CP1 would have no effect on seasonal San Joaquin River flows compared with the Existing Condition and No-Action Alternative. Based on these results CP1 would have no impact on Delta fisheries or transport mechanisms within the lower San Joaquin River and Delta under CP1. Mitigation for this impact is not needed, and thus not proposed.

Table 11-15. San Joaquin River Flow at Vernalis

		Existing Condition	CP1 (2005)		No-Action Alternative	CP1 (2030)	
Month	**Water Year**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**
January	Average	4,770	4,770	0	4,764	4,764	0
	W	9,273	9,273	0	9,097	9,097	0
	AN	4,223	4,223	0	4,259	4,259	0
	BN	2,986	2,986	0	3,081	3,081	0
	D	2,084	2,084	0	2,160	2,160	0
	C	1,673	1,673	0	1,746	1,746	0
February	Average	6,265	6,265	0	6,143	6,143	0
	W	11,036	11,036	0	10,845	10,845	0
	AN	6,047	6,047	0	6,179	6,179	0
	BN	5,767	5,767	0	5,565	5,565	0
	D	2,642	2,642	0	2,528	2,528	0
	C	2,161	2,161	0	2,014	2,014	0
March	Average	7,133	7,133	0	7,003	7,003	0
	W	13,443	13,443	0	13,170	13,170	0
	AN	6,788	6,788	0	6,674	6,673	0
	BN	5,322	5,322	0	5,293	5,293	0
	D	2,963	2,963	0	2,895	2,895	0
	C	2,176	2,176	0	2,129	2,129	0
April	Average	6,720	6,720	0	7,533	7,533	0
	W	11,420	11,420	0	12,614	12,614	0
	AN	6,671	6,671	0	7,799	7,798	0
	BN	5,852	5,852	0	6,910	6,910	0
	D	3,726	3,726	0	4,112	4,112	0
	C	2,087	2,087	0	2,118	2,118	0

Table 11-15. San Joaquin River Flow at Vernalis (contd.)

		Existing Condition	CP1 (2005)		No-Action Alternative	CP1 (2030)	
Month	**Water Year**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**
May	Average	6,204	6,204	0	6,234	6,234	0
	W	11,268	11,268	0	11,135	11,135	0
	AN	5,611	5,611	0	5,987	5,987	0
	BN	5,010	5,010	0	5,108	5,108	0
	D	3,070	3,070	0	3,111	3,111	0
	C	1,920	1,920	0	1,862	1,862	0
June	Average	4,739	4,739	0	4,671	4,671	0
	W	9,451	9,451	0	9,390	9,390	0
	AN	5,608	5,609	0	5,326	5,326	0
	BN	2,424	2,424	0	2,471	2,470	0
	D	1,598	1,598	0	1,554	1,554	0
	C	1,076	1,076	0	1,035	1,035	0
July	Average	3,202	3,202	0	3,208	3,208	0
	W	6,556	6,556	0	6,660	6,660	0
	AN	2,783	2,784	0	2,767	2,768	0
	BN	1,775	1,775	0	1,733	1,733	0
	D	1,282	1,282	0	1,216	1,216	0
	C	898	898	0	880	880	0
August	Average	2,029	2,029	0	2,040	2,041	0
	W	3,099	3,099	0	3,158	3,159	0
	AN	2,020	2,020	0	2,014	2,015	0
	BN	1,828	1,828	0	1,817	1,816	0
	D	1,342	1,342	0	1,315	1,315	0
	C	984	984	0	993	993	0
September	Average	2,331	2,331	0	2,340	2,340	0
	W	3,274	3,274	0	3,317	3,317	0
	AN	2,328	2,328	0	2,312	2,312	0
	BN	2,109	2,109	0	2,119	2,119	0
	D	1,795	1,795	0	1,774	1,775	0
	C	1,358	1,358	0	1,355	1,355	0
October	Average	2,757	2,757	0	2,753	2,753	0
	W	3,112	3,112	0	3,107	3,107	0
	AN	2,446	2,446	0	2,424	2,424	0
	BN	2,749	2,749	0	2,718	2,718	0
	D	2,686	2,686	0	2,710	2,710	0
	C	2,416	2,416	0	2,423	2,423	0

Table 11-15. San Joaquin River Flow at Vernalis (contd.)

		Existing Condition	CP1 (2005)		No-Action Alternative	CP1 (2030)	
Month	**Water Year**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**
November	Average	2,633	2,633	0	2,603	2,603	0
	W	3,372	3,372	0	3,340	3,340	0
	AN	2,213	2,213	0	2,176	2,176	0
	BN	2,412	2,412	0	2,360	2,360	0
	D	2,388	2,388	0	2,355	2,355	0
	C	2,075	2,075	0	2,088	2,088	0
December	Average	3,199	3,199	0	3,263	3,263	0
	W	5,081	5,081	0	5,178	5,178	0
	AN	2,916	2,916	0	2,899	2,899	0
	BN	2,705	2,705	0	2,753	2,753	0
	D	2,047	2,047	0	2,123	2,123	0
	C	1,710	1,710	0	1,785	1,785	0

Note:
A negative percentage change reflects a reduction in San Joaquin River flow
Key:
AN = above-normal
BN = below-normal
C = critical
cfs = cubic feet per second
CP = Comprehensive Plan
D = dry
W = wet

Impact Aqua-21 (CP1): Reduction in Low-Salinity Habitat Conditions Resulting from an Upstream Shift in X2 Location CP1 operation would result in a less than 0.5 km movement upstream or downstream from the X2 location from its location during February through May or September through November under the Existing Condition or No-Action Alternative, and thus cause minimal reduction in low-salinity habitats. This impact would be less than significant.

Operations of upstream storage reservoirs have the potential to affect the location of X2 as a result of changes in freshwater flows from the upstream tributaries through the Delta. X2 serves as a surrogate metric for a variety of habitat conditions within the Delta that directly, or indirectly, affects fish and other aquatic resources. For purposes of evaluating changes in habitat quantity and quality for estuarine species, a significance criterion of an upstream change in X2 location less than 1 km of the location under either the Existing Condition or the No-Action Alternative was considered to be less than significant. The criterion was applied to a comparison of hydrologic model results for basis-of-comparison conditions and CP1, by month and water year, for February through May and September through November.

Results of the comparison of X2 position under the Existing Condition, No-Action Alternative, and CP1 are summarized in Table 11-16. The results showed that changes in X2 location under CP1 as compared with the Existing Condition would be less than 1 km (all were less than 0.5 km) with both variable upstream and downstream movement of the X2 location, depending on month and water year. Changes in X2 location between the No-Action Alternative and CP1 assuming future operating conditions would also be small (less than 0.2 km). These results are consistent with model results for Delta outflow that showed a less-than-significant change in flows under CP1. Based on these results, CP1 would have a less-than-significant impact on low-salinity habitat conditions within the Bay-Delta. Mitigation for this impact is not needed, and thus not proposed.

Table 11-16. X2 Under the Existing Condition, No-Action Alternative, and CP1

		Existing Condition	CP1 (2005)		No-Action Alternative	CP1 (2030)	
Month	**Water Year**	**Location (km)**	**Location (km)**	**Difference (km)**	**Location (km)**	**Location (km)**	**Difference (km)**
January	Average	67.5	67.5	0.0	67.3	67.3	0.0
	W	53.6	53.6	0.0	53.7	53.7	0.0
	AN	61.7	61.7	0.0	61.6	61.6	0.0
	BN	72.1	72.0	-0.1	71.7	71.6	-0.1
	D	77.9	78.0	0.1	77.4	77.6	0.1
	C	82.2	82.0	-0.1	81.9	82.1	0.2
February	Average	60.9	60.9	0.0	60.8	60.9	0.0
	W	50.4	50.4	0.0	50.4	50.4	0.0
	AN	54.8	54.8	0.0	54.6	54.6	0.1
	BN	61.0	60.9	0.0	60.9	60.9	0.0
	D	70.1	70.1	0.0	69.9	70.0	0.0
	C	76.2	76.2	0.0	75.9	76.1	0.2
March	Average	60.9	60.9	0.0	60.9	60.9	0.0
	W	52.1	52.1	0.0	52.1	52.1	0.0
	AN	53.6	53.7	0.0	53.7	53.7	0.0
	BN	63.3	63.4	0.1	63.3	63.4	0.0
	D	67.1	67.0	-0.1	67.2	67.1	0.0
	C	75.2	75.3	0.1	75.1	75.1	0.1
April	Average	63.5	63.5	0.0	63.4	63.4	0.0
	W	54.5	54.5	0.0	54.3	54.3	0.0
	AN	58.6	58.6	0.0	58.4	58.4	0.0
	BN	64.5	64.5	0.0	64.1	64.1	0.0
	D	69.9	69.9	0.0	69.9	69.8	-0.1
	C	77.5	77.5	0.0	77.6	77.6	0.0

Table 11-16. X2 Under the Existing Condition, No-Action Alternative, and CP1 (contd.)

		Existing Condition	CP1 (2005)		No-Action Alternative	CP1 (2030)	
Month	**Water Year**	**Location (km)**	**Location (km)**	**Difference (km)**	**Location (km)**	**Location (km)**	**Difference (km)**
May	Average	67.5	67.5	0.0	67.7	67.7	0.0
	W	57.6	57.6	0.0	57.7	57.7	0.0
	AN	62.7	62.7	0.0	62.6	62.6	0.1
	BN	68.3	68.4	0.1	68.3	68.4	0.1
	D	74.4	74.4	0.0	74.8	74.7	-0.1
	C	82.5	82.5	0.0	82.9	82.8	-0.1
June	Average	74.5	74.6	0.0	74.7	74.7	0.0
	W	65.0	65.0	0.0	65.2	65.2	0.0
	AN	72.6	72.8	0.2	72.7	72.8	0.1
	BN	76.6	76.6	0.0	76.7	76.8	0.1
	D	80.4	80.5	0.0	80.7	80.7	0.0
	C	85.9	85.9	0.0	86.0	86.0	0.0
July	Average	80.5	80.5	0.0	80.5	80.5	0.0
	W	74.4	74.4	0.0	74.5	74.5	0.0
	AN	78.1	78.2	0.1	78.4	78.4	0.1
	BN	81.7	81.7	0.0	81.6	81.6	0.0
	D	84.8	84.9	0.0	84.8	84.8	0.0
	C	88.1	88.1	0.0	88.0	88.0	0.0
August	Average	85.6	85.6	0.0	85.6	85.5	0.0
	W	82.7	82.6	0.0	82.8	82.8	0.0
	AN	83.7	83.8	0.0	83.9	83.9	0.0
	BN	85.6	85.6	0.0	85.5	85.4	0.0
	D	87.8	87.8	0.0	87.5	87.5	0.0
	C	90.4	90.3	-0.1	90.2	90.2	0.0
September	Average	83.7	83.7	0.0	83.7	83.6	0.0
	W	73.4	73.4	0.0	73.5	73.5	0.0
	AN	81.4	81.4	0.0	81.4	81.4	0.0
	BN	88.8	88.8	0.0	88.8	88.8	0.0
	D	90.2	90.2	0.0	90.0	89.9	-0.1
	C	92.5	92.4	-0.1	92.3	92.3	0.0
October	Average	83.9	83.9	0.0	83.9	83.9	0.0
	W	73.6	73.6	0.0	73.7	73.7	0.0
	AN	79.8	79.8	0.0	79.8	79.8	0.0
	BN	88.9	88.9	0.0	88.9	88.9	0.0
	D	91.4	91.4	0.0	91.3	91.2	-0.1
	C	93.3	93.2	-0.1	93.1	93.0	-0.1

Table 11-16. X2 Under the Existing Condition, No-Action Alternative, and CP1 (contd.)

		Existing Condition	CP1 (2005)		No-Action Alternative	CP1 (2030)	
Month	**Water Year**	**Location (km)**	**Location (km)**	**Difference (km)**	**Location (km)**	**Location (km)**	**Difference (km)**
November	Average	82.2	82.3	0.1	82.2	82.3	0.1
	W	73.1	73.1	0.0	73.2	73.2	0.0
	AN	78.4	78.4	0.0	78.4	78.5	0.1
	BN	84.8	85.3	0.5	84.8	85.2	0.4
	D	88.9	89.0	0.0	88.8	88.9	0.1
	C	92.6	92.7	0.0	92.8	92.6	-0.1
December	Average	76.1	76.2	0.1	76.0	76.0	0.0
	W	62.9	63.0	0.1	63.0	63.1	0.1
	AN	76.4	76.7	0.3	76.4	76.6	0.2
	BN	81.4	81.3	0.0	81.1	81.1	0.0
	D	82.8	82.9	0.1	82.6	82.7	0.1
	C	87.9	87.9	0.0	87.8	87.7	-0.1

Key:
AN = above-normal
BN = below-normal
C = critical
CP = Comprehensive Plan
D = dry
km = kilometer
W = wet

Impact Aqua-22 (CP1): Increase in Mortality of Species of Primary Management Concern as a Result of Increased Reverse Flows in Old and Middle Rivers CP1 operation would result in minimal changes to reverse flows in Old and Middle rivers. The increases in reverse flows under CP1 do not exceed -5,000 cfs; thus, the increases in reverse flows are not expected to contribute to an increase in the vulnerability of delta smelt, longfin smelt, Chinook salmon, juvenile striped bass, or threadfin shad—but summer Old and Middle river flows could contribute to an increase in vulnerability of other resident warm-water fish to increased salvage and potential losses. This impact would be less than significant.

Results of the analysis show two occurrences relative to the Existing Condition, and one compared with the No-Action Alternative when reverse flows within Old and Middle rivers would increase by more than 5 percent; however, neither change resulted in a flow greater (more negative) than -5,000 cfs. Two of these events occurred in critical water years, which would be expected as a result of greater export operations under CP1. During January, operations under CP1 would result in an increase in reverse flow of 5 percent during critical years under future conditions (Table 11-17). Based on results of the delta smelt analysis of the relationship between reverse flows and delta smelt salvage, the increase from approximately 3,900 cfs in January under the basis-of-comparison in a critical water year to approximately 4,100 cfs under CP1would not be expected to result in a significant increase in adverse impacts to delta smelt or longfin smelt.

Table 11-17. Old and Middle River Reverse Flows for the Existing Condition, No-Action Alternative, and CP1

		Existing Condition	CP1 (2005)		No-Action Alternative	CP1 (2030)	
Month	Water Year	Flow (cfs)	Flow (cfs)	Percent Change	Flow (cfs)	Flow (cfs)	Percent Change
January	Average	-3,542	-3,544	0	-3,553	-3,568	0
	W	-2,034	-2,034	0	-2,151	-2,151	0
	AN	-3,654	-3,645	0	-3,574	-3,488	-2
	BN	-4,240	-4,240	0	-4,240	-4,240	0
	D	-4,773	-4,791	0	-4,772	-4,772	0
	C	-4,033	-4,029	0	-3,940	-4,131	5
February	Average	-3,293	-3,255	-1	-3,358	-3,367	0
	W	-2,745	-2,738	0	-2,950	-2,970	1
	AN	-3,248	-3,061	-6	-3,165	-3,139	-1
	BN	-3,335	-3,303	-1	-3,291	-3,250	-1
	D	-4,016	-4,001	0	-4,045	-4,044	0
	C	-3,391	-3,393	0	-3,482	-3,573	3
March	Average	-2,784	-2,810	1	-2,877	-2,867	0
	W	-1,792	-1,780	-1	-2,023	-2,046	1
	AN	-4,021	-4,227	5	-4,260	-4,272	0
	BN	-4,005	-4,001	0	-3,982	-3,983	0
	D	-2,951	-2,873	-3	-2,918	-2,834	-3
	C	-2,023	-2,138	6	-1,994	-1,991	0
April	Average	955	955	0	1,060	1,059	0
	W	2,706	2,706	0	2,798	2,793	0
	AN	1,087	1,087	0	1,314	1,314	0
	BN	697	697	0	898	898	0
	D	-244	-244	0	-207	-205	-1
	C	-874	-874	0	-872	-872	0
May	Average	491	490	0	416	412	-1
	W	2,077	2,077	0	1,781	1,781	0
	AN	562	562	0	646	646	0
	BN	277	277	0	270	270	0
	D	-674	-674	0	-696	-696	0
	C	-1,018	-1,026	1	-936	-966	3
June	Average	-3,654	-3,652	0	-3,718	-3,736	0
	W	-4,226	-4,226	0	-4,354	-4,354	0
	AN	-4,825	-4,825	0	-4,818	-4,818	0
	BN	-4,137	-4,126	0	-4,119	-4,227	3
	D	-3,079	-3,079	0	-3,205	-3,204	0
	C	-1,542	-1,542	0	-1,542	-1,542	0

Table 11-17. Old and Middle River Reverse Flows for the Existing Condition, No-Action Alternative, and CP1 (contd.)

		Existing Condition	CP1 (2005)		No-Action Alternative	CP1 (2030)	
Month	**Water Year**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**
July	Average	-9,502	-9,514	0	-9,292	-9,325	0
	W	-8,948	-8,947	0	-8,905	-8,904	0
	AN	-9,993	-9,949	0	-9,929	-9,916	0
	BN	-10,886	-10,907	0	-10,903	-10,859	0
	D	-10,998	-11,038	0	-10,419	-10,504	1
	C	-6,355	-6,397	1	-5,928	-6,089	3

Note:
A positive percentage change reflects more negative reverse flows under CP1 when compared to the Existing Condition or the No-Action Alternative.

Key:
AN = above-normal
BN = below-normal
C = critical
cfs = cubic feet per second
CP = Comprehensive Plan
D = dry
W = wet

Juvenile Chinook salmon and steelhead are migrating through the Delta during January, and an increase in average monthly reverse flows of around 200 cfs would be expected to increase the potential risk of increased mortality to these species. However, given the tidal volumes and hydrodynamics of the Old and Middle river region, it is not expected that the change in reverse flows in January in a critical year would result in a detectable change in fish survival. The majority of juvenile Chinook salmon emigrating from the San Joaquin River typically migrate downstream later in dry years and would not be expected to occur in high numbers within Old and Middle rivers in January.

The increase in reverse flows estimated to occur under CP1 in critical and above-normal water years in March would exceed 5 percent, but would not increase the flows beyond -5,000 cfs. The potential change in Old and Middle river flows of approximately 100 to 200 cfs may result in a small increase in vulnerability of fish, particularly delta smelt and longfin smelt, to CVP and SWP salvage, resulting in a potentially significant impact. The increased reverse flows would not result in a significant increase in risk of mortality for Chinook salmon. The potential change in Old and Middle river flows would result in a less-than-significant impact to juvenile striped bass, threadfin shad, and other resident warm-water fish inhabiting the south Delta, due mainly to larger resident populations of these species.

The potential increase in losses during January and March is considered to be less than significant for Chinook salmon, steelhead, delta smelt, longfin smelt, and Chinook salmon, but potentially significant for other resident warm-water fish. Mitigation for this impact is not proposed because operations will be guided by RPAs established by NMFS and USFWS BOs to reduce any impacts to listed fish species.

Impact Aqua-23 (CP1): Increase in the Risk of Entrainment or Salvage of Species of Primary Management Concern at CVP and SWP Export Facilities Due to Changes in CVP and SWP Exports CP1 operations may result in an increase in CVP and SWP exports, which is assumed to result in a direct proportional increase in the risk of fish being entrained and salvaged at the facilities. Future operations of the SWP and CVP export facilities would continue to be managed and regulated in accordance with incidental take limits established for each of the protected fish by USFWS, NMFS, and CDFW. The resulting impact to Chinook salmon, steelhead, longfin smelt, striped bass, and splittail would be less than significant; the resulting impact to delta smelt would be potentially significant. Overall, this impact would be potentially significant.

Results of entrainment loss modeling at the CVP and SWP export facilities are presented in Table 11-18 for CP1. The initial modeling was conducted using average fish densities developed from past fish salvage monitoring at the SWP and CVP export facilities. Average monthly water exports were used in the analysis based on hydrologic simulation modeling. The indices of the potential risk of entrainment for some species, such as Chinook salmon, were not estimated separately for each species (e.g., winter-run Chinook salmon) in these analyses. These indices were calculated for wet, above-normal, below-normal, dry, and critical water year types, and for an average across all years (no water year type specified). The total numbers of fish lost annually, by species, are presented in Attachment 1 of the *Fisheries and Aquatic Ecosystems Technical Report.* The difference between the nonoperations-related and operations-related fish mortality is represented as the entrainment index, shown in Table 11-18, to represent the effect of project operations on each fish species for the CVP and SWP.

Table 11-18. Indices of Entrainment at the CVP and SWP facilities Under the Existing Condition, No-Action Alternative, and CP1

Species	Water Year	CP1 Minus Existing Condition	Percent Change	CP1 Minus No-Action Alternative	Percent Change
Delta Smelt	Average	6	0.0	111	0.3
	W	-6	-0.0	7	0.0
	AN	-16	-0.0	-29	-0.1
	BN	-33	-0.1	273	0.8
	D	1	0.0	1	0.0
	C	105	0.4	452	2.0
Chinook Salmon	Average	-8	-0.0	88	0.2
	W	-23	-0.0	66	0.1
	AN	-8	-0.0	-92	-0.2
	BN	-59	-0.1	83	0.2
	D	-88	-0.2	-98	-0.2
	C	206	0.6	597	1.8
Longfin Smelt	Average	3	0.0	14	0.2
	W	-1	-0.0	2	0.0
	AN	2	0.0	-1	-0.0
	BN	0	-0.0	3	0.1
	D	-1	-0.0	-2	-0.0
	C	22	0.4	93	1.8
Steelhead	Average	-4	-0.1	4	0.1
	W	-4	-0.1	10	0.2
	AN	-10	-0.2	-18	-0.4
	BN	-9	-0.2	-10	-0.2
	D	-15	-0.4	-16	-0.4
	C	22	0.8	57	2.1
Striped Bass	Average	2533	0.2	5,666	0.4
	W	1518	0.1	1,399	0.1
	AN	837	0.1	1,533	0.1
	BN	1092	0.1	8,237	0.6
	D	6826	0.6	8,789	0.8
	C	1671	0.3	11,359	1.9
Splittail	Average	503	0.2	967	0.4
	W	-6	-0.0	11	0.0
	AN	-380	-0.1	-110	-0.0
	BN	-182	-0.1	3,141	1.2
	D	435	0.2	796	0.4
	C	451	0.4	1,835	1.9

Note:
Negative percentage change reflects a reduction in entrainment risk while a positive percentage change reflects an increase in entrainment risk.

Key:
AN = above-normal
BN = below-normal
C = critical
CP = Comprehensive Plan
CVP = Central Valley Project
D = dry
SWP = State Water Project
W = wet

The greatest change in the risk of entrainment at the CVP and SWP export facilities would be expected to occur in dry and critical water year types when export rates would increase, especially during February and summer months. Entrainment indices under CP1 operations indicate a relatively minor increase, on average, in salvage for most species (e.g., delta smelt, steelhead, Chinook salmon, and longfin smelt). Although the risk of entrainment showed both increases and decreases depending on species and water year type, the general trend was a small incremental increase in the risk of entrainment/salvage losses at the CVP and SWP export facilities when compared to the Existing Condition. Species with relatively lower abundance at the CVP and SWP, such as longfin smelt, during months of the highest exports, would be less affected by CP1 operations, with entrainment indices typically representing a net benefit as a result of CP1 relative to the Existing Condition. Species with relatively higher abundance at the CVP and SWP fish facilities, such as splittail and striped bass, would experience increased risk of mortality due to higher exports during June and July, as these species are generally collected at their highest abundances during these months. Under CP1, the risk of entrainment of juvenile Chinook salmon, whose occurrence at the facilities is highest during February through May, would increase as a result of generally higher project export rates during these months when compared to the Existing Condition.

Results of the entrainment risk calculations for delta smelt showed a change of less than 1 percent from the Existing Condition in all water year types and up to a 2-percent increase during critical water years (Table 11-18). The risk of increased losses of delta smelt would be greatest in critical years with a net reduction in losses under CP1 relative to the No-Action Alternative. Although the incremental change in the risk of delta smelt losses resulting from CVP and SWP export operations would be small, the delta smelt population abundance is currently at such critically low levels that even a small increase in the risk of losses is considered to be potentially significant. The increase in risk would also contribute to cumulative factors affecting the survival of delta smelt.

The estimated change in the risk of losses for Chinook salmon under CP1 follows a similar pattern to that described for delta smelt (Table 11-18). Overall, CP1 would result in a small increase in the risk of losses relative to both the Existing Condition and No-Action Alternative. Given the numbers of juvenile Chinook salmon produced each year in the Central Valley, the relatively small incremental increase in the risk of entrainment/salvage at the CVP and SWP export facilities is considered to be a less-than-significant direct impact but would contribute incrementally to the overall cumulative factors affecting juvenile Chinook salmon survival within the Delta and population dynamics of the stocks.

The estimated change in the risk of longfin smelt entrainment/salvage under CP1 compared with the Existing Condition and No-Action Alternative include small positive and negative changes (less than 2 percent), depending on water year type (Table 11-18). Given the greater abundance of longfin smelt, when compared to delta smelt, their 2-year life history, and geographic distribution within the estuary, these small changes in the risk of entrainment are considered to be less than significant.

The estimated change in the risk to steelhead of entrainment/salvage at the CVP and SWP export facilities under CP1 are summarized in Table 11-18. The increase in risk of steelhead losses in wet years (as compared with the No-Action Alternative) and critical water years (as compared with the Existing Condition) would be less than significant based on the abundance of Sacramento and San Joaquin river juvenile steelhead migrating through the Delta, but would contribute directly to cumulative factors affecting the survival and population dynamics of Central Valley steelhead. The predicted increase in potential entrainment risk for steelhead under critical water years represents an initial estimate of the change (percentage) between the CP1 and the Existing Condition and No-Action Alternatives and does not allow the predicted losses to be evaluated at the population level (see Attachment 1 of the *Fisheries and Aquatic Ecosystems Technical Report).*

The change in risk to juvenile striped bass for entrainment/salvage at the CVP and SWP export facilities are summarized in Table 11-18. The changes in risk in all water year types of less than 2 percent would be less than significant to striped bass but would contribute to the cumulative factors affecting striped bass survival and population dynamics in the Delta. The increased losses, particularly in drier water years when juvenile striped bass production is lower, would contribute to the cumulative effects of factors affecting juvenile striped bass survival in the Delta.

Results of the risk estimates for juvenile splittail losses relative to the Existing Condition and No-Action Alternative show a pattern similar to other species (Table 11-18). The increased risk index of less than 2 percent was considered to be a less-than-significant impact. The simulated loss index increased during dry and critical water years. Higher risk of entrainment/salvage losses in drier water years has a potentially greater effect on abundance of juvenile splittail since reproductive success and overall juvenile abundance is typically lower in the Delta in dry years. The increased risk of losses in drier years would not be potentially significant, but the increased losses would contribute to cumulative factors affecting survival of juvenile splittail within the Delta.

Impact Aqua-23 (CP1) is considered to be less than significant for all species except delta smelt which could experience potentially significant effects. Mitigation for this impact is not proposed because operations will be guided by RPAs established by NMFS and USFWS BOs to reduce any impacts to listed fish species.

CVP/SWP Service Areas

Impact Aqua-24 (CP1): Impacts on Aquatic Habitats and Fish Populations in the CVP and SWP Service Areas Resulting from Modifications to Existing Flow

Regimes CP1 implementation could result in modified flow regimes that would reduce the frequency and magnitude of high winter flows along the Sacramento River; however, hydrologic effects to tributaries and reservoirs with CVP and SWP dams, as well as the conveyances south of the Delta would be substantially less than impacts on the lower Sacramento River. Changes in hydrology could affect aquatic habitats that provide habitat for the fish communities. However, these changes would not result in substantial effects on the distribution or abundance of these species in the CVP and SWP service areas. Therefore, this impact would be less than significant.

CP1 implementation could result in modified flow regimes that would shift the frequency and magnitude of high winter flows along the Sacramento River; however, the hydrologic effects in tributaries (e.g., San Joaquin River, canals), reservoirs (e.g., New Melones and San Luis) with CVP and SWP dams, and conveyances are expected to be substantially less than impacts on the lower Sacramento River. The change in hydrology and reservoir levels could affect aquatic habitats for local resident fish communities, but these changes would not result in substantial effects on the distribution or abundance of these species in the CVP and SWP service areas. The effects from CP1 on CVP and SWP reservoir elevations, filling, spilling, and planned releases, and the resulting flows downstream from those reservoirs, would be small and well within the range of variability that commonly occurs in these reservoirs and downstream. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

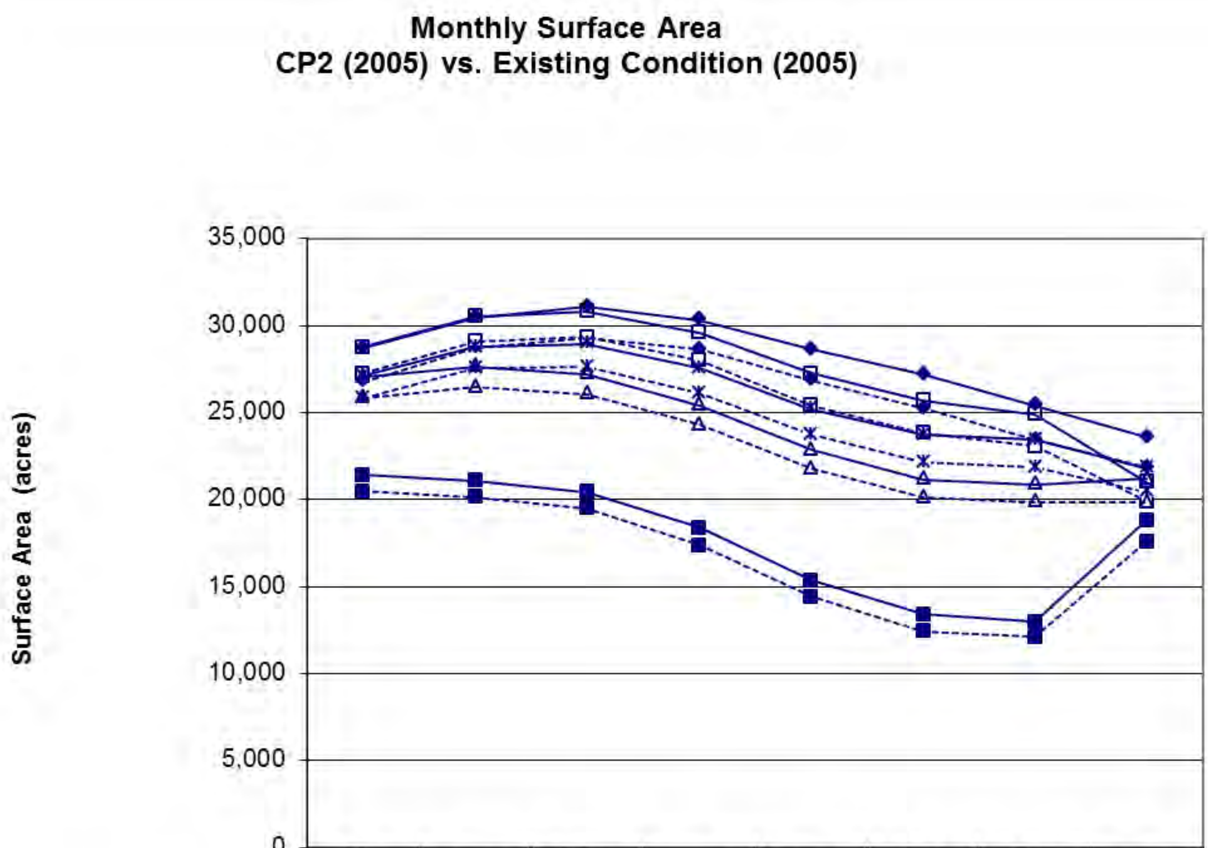
CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

As with CP1, CP2 focuses on increasing water supply reliability and increasing anadromous fish survival. CP2 primarily consists of raising Shasta Dam by 12.5 feet, which, in combination with spillway modifications, would increase the height of the reservoir's full pool by 14.5 feet and enlarge the total storage capacity in the reservoir by 443,000 acre-feet. The existing TCD would also be extended to achieve efficient use of the expanded cold-water pool. Shasta Dam operational guidelines would continue essentially unchanged, except during dry years and critical years, when 120,000 acre-feet and 60,000 acre-feet, respectively, of the increased storage capacity in Shasta Reservoir reserved to specifically focus on increasing M&I deliveries. CP2 would help reduce future water shortages through increasing drought year and average year water supply reliability for agricultural and M&I deliveries. In addition, the increased depth and volume of the cold-water pool in Shasta Reservoir would contribute to improving seasonal water temperatures for anadromous fish in the Sacramento River between Shasta Dam and Red Bluff.

Shasta Lake and Vicinity

Impact Aqua-1 (CP2): Effects on Nearshore, Warm-Water Habitat in Shasta Lake from Project Operations Under CP2, project operations would contribute to an increase in the surface area and WSEL of Shasta Lake, which would in turn increase the area and productivity of nearshore, warm-water habitat. CP2 operations would also result in reduced monthly fluctuations in WSEL, which would contribute to increased reproductive success, young-of-the-year production, and the juvenile growth rate of warm-water fish species. Similar to CP1, the value of existing structural habitat improvements (e.g., piles, willow plantings) would be diminished; however, the existing habitat-enhancement features would become functional during reservoir drawdowns later in the season and during normal and drier years; however, environmental commitments during construction, which include placing brush in the new inundation varial zone to extend and enhance existing fish habitat structures, would offset this effect (See Chapter 2, "Alternatives," for additional detailed descriptions of the environmental commitments). Additionally, large areas of the shoreline would not be cleared, and the vegetation along these sections would be inundated periodically. In the short term, this newly inundated vegetation will initially increase warm-water fish habitat, with decay expected to occur over several decades. This impact would be less than significant.

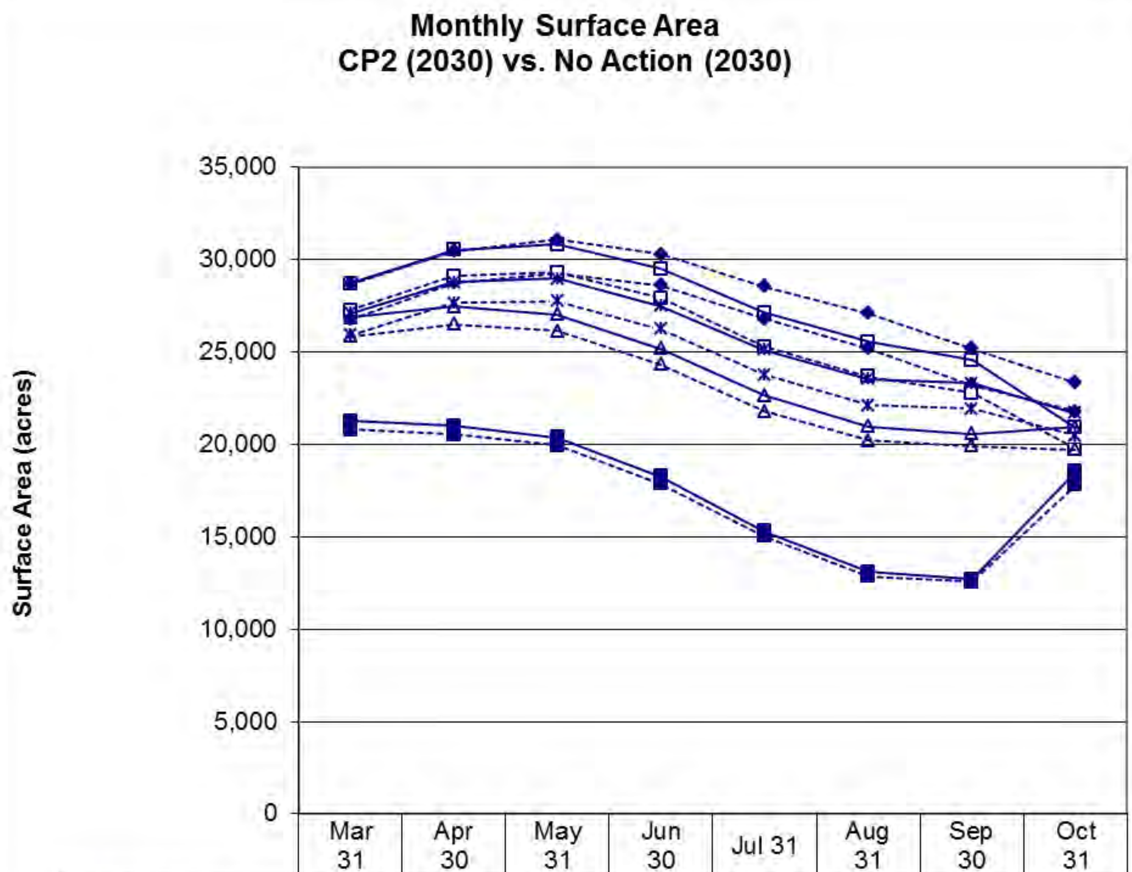
This impact would be similar to Impact Aqua-1 (CP1), but the surface area would be larger under the 12.5-foot dam raise than under the 6.5-foot dam raise. CalSim-II modeling shows that the surface area of Shasta Lake would be larger under the CP2 than the Existing Condition or No-Action Alternative in all five water year types (Figures 11-16 and 11-17).



	Mar 31	Apr 30	May 31	Jun 30	Jul 31	Aug 31	Sep 30	Oct 31
EC W	26,790	28,748	29,277	28,624	26,872	25,226	23,413	21,827
EC AN	27,245	29,082	29,336	27,992	25,400	23,826	23,061	19,906
EC BN	25,807	27,534	27,621	26,104	23,714	22,114	21,837	20,425
EC D	25,850	26,467	26,058	24,300	21,754	20,093	19,840	19,828
EC C	20,467	20,142	19,500	17,381	14,400	12,418	12,111	17,572
CP2 2005 W	28,683	30,458	31,083	30,334	28,625	27,177	25,409	23,590
CP2 2005 AN	28,750	30,541	30,832	29,595	27,244	25,710	24,895	21,007
CP2 2005 BN	27,113	28,780	28,964	27,542	25,197	23,700	23,425	21,813
CP2 2005 D	27,028	27,636	27,226	25,428	22,865	21,169	20,879	21,210
CP2 2005 C	21,404	21,076	20,452	18,375	15,342	13,395	12,971	18,813

Key:
AN = above-normal water
BN= below-normal water years
C = critical water years
CP = Comprehensive Plan
D = dry water years
EC = Existing Condition
W = wet water years

Figure 11-16. Average Monthly Surface Area for Each Water Year Type Within the Shasta Lake Vicinity of the Primary Study Area, CP2 Versus the Existing Condition



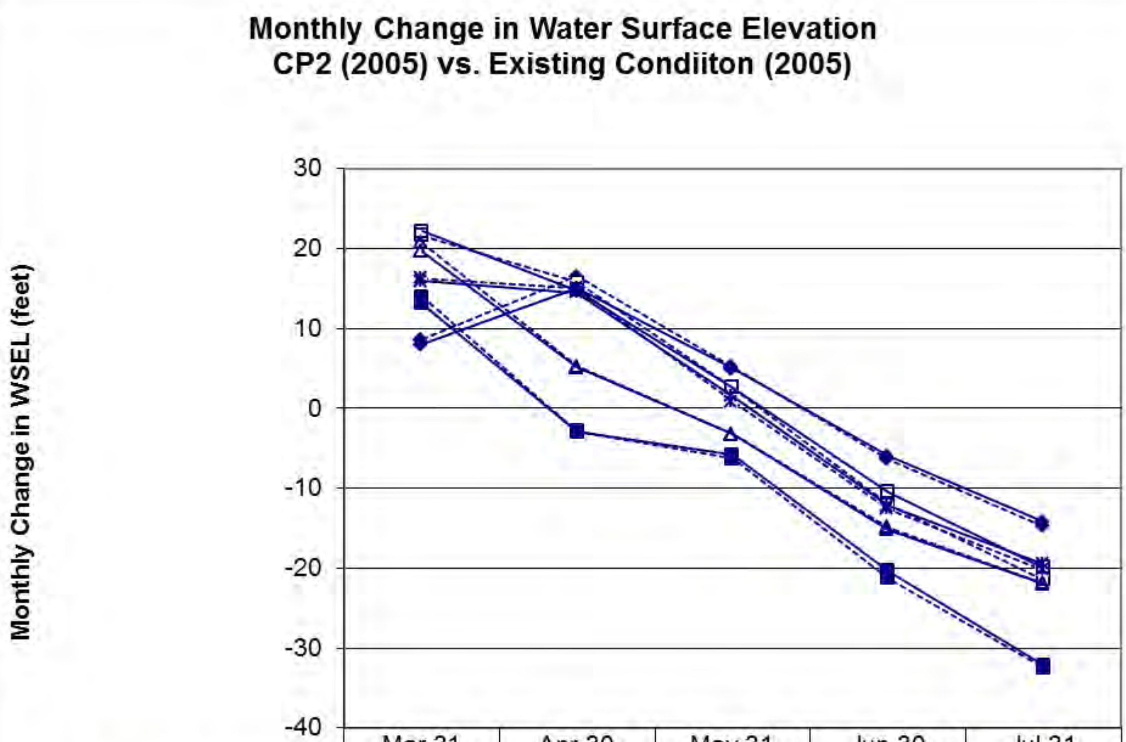
	Mar 31	Apr 30	May 31	Jun 30	Jul 31	Aug 31	Sep 30	Oct 31
NA W	26,775	28,735	29,273	28,604	26,797	25,183	23,205	21,808
NA AN	27,258	29,117	29,325	27,921	25,294	23,687	22,800	19,759
NA BN	25,918	27,662	27,770	26,239	23,764	22,137	21,923	20,469
NA D	25,843	26,514	26,134	24,346	21,780	20,209	19,910	19,728
NA C	20,801	20,548	19,942	17,866	15,026	12,873	12,556	17,800
CP2 2030 W	28,670	30,446	31,078	30,287	28,541	27,085	25,189	23,343
CP2 2030 AN	28,727	30,540	30,824	29,523	27,130	25,553	24,563	20,891
CP2 2030 BN	27,085	28,777	28,968	27,497	25,110	23,530	23,305	21,689
CP2 2030 D	26,863	27,455	27,043	25,202	22,650	20,971	20,561	20,933
CP2 2030 C	21,267	21,006	20,364	18,273	15,299	13,085	12,712	18,527

Key:
AN = above-normal water
BN= below-normal water years
C = critical water years
CP = Comprehensive Plan
D = dry water years
NA = No-Action
W = wet water years

Figure 11-17. Average Monthly Surface Area for Each Water Year Type Within the Shasta Lake Vicinity of the Primary Study Area, CP2 Versus No-Action

Monthly WSEL fluctuations were compared with projections for water supply demand. For CP2, with a 2005 water supply demand, 44 percent of monthly changes in projected WSEL (i.e., 11 of the 25 total projections made for the 5 months from March through July for all five water year types) showed decreased monthly WSEL fluctuations relative to the Existing Condition and 4 percent showed increased monthly WSEL fluctuations (Figure 11-18). For CP2, with a projected 2030 water supply demand, 36 percent of monthly changes in projected WSEL showed decreased WSEL fluctuations relative to the No-Action Alternative and 16 percent showed increased monthly WSEL fluctuations (Figure 11-19). Under CP2, none of the changes in monthly WSEL fluctuation is different enough from the Existing Condition to warrant the investigation of daily WSEL fluctuation.

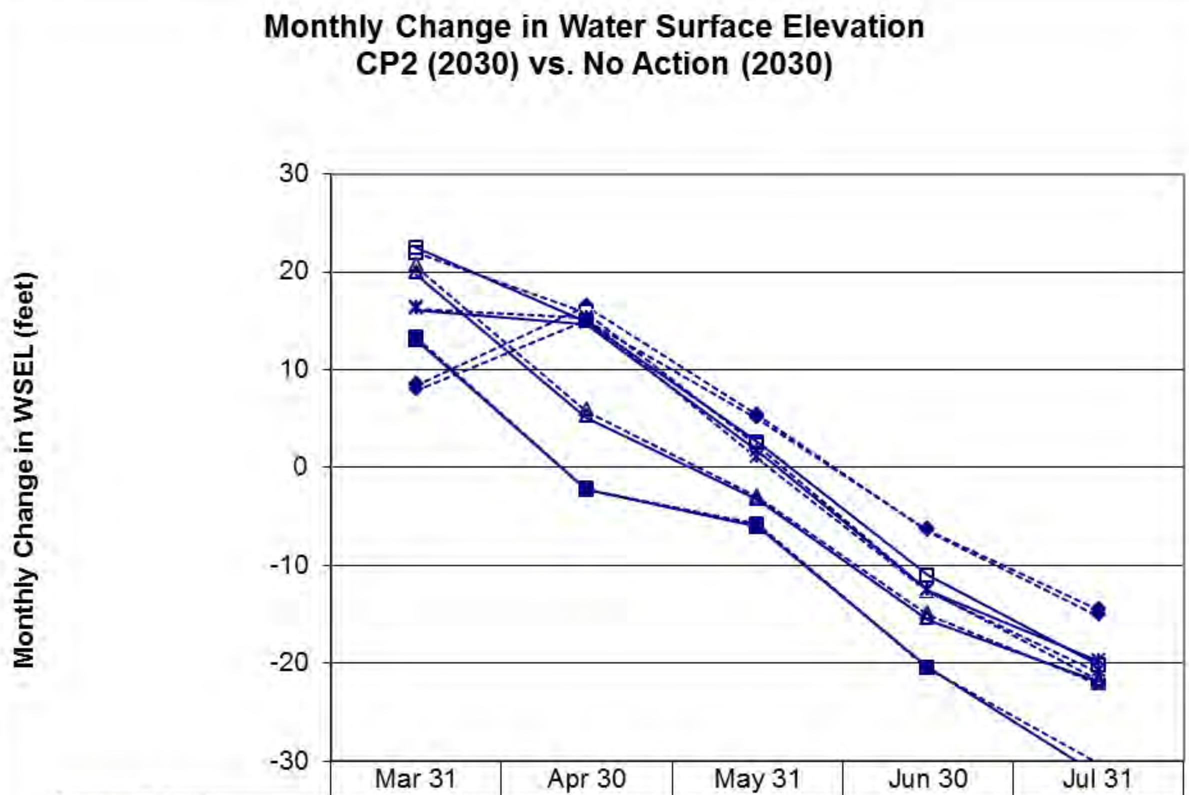
Increases in the overall surface area and WSEL under CP2 would increase the area of available warm-water habitat and stimulate biological productivity, including fish production, of the entire lake for a period of time, possibly for several decades. Furthermore, reductions in the magnitude of monthly WSEL fluctuations, along with the environmental commitment to install and extend existing habitat brush piles and structures, could contribute to increased reproductive success, young-of-the-year production, and juvenile growth rate of warm-water fish species. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.



	Mar 31	Apr 30	May 31	Jun 30	Jul 31
EC W	9	16	5	-6	-15
EC AN	22	16	3	-12	-21
EC BN	16	15	1	-13	-20
EC D	21	5	-3	-15	-22
EC C	14	-3	-6	-21	-32
CP2 (2005) W	8	15	5	-6	-14
CP2 (2005) AN	22	15	3	-10	-20
CP2 (2005) BN	16	15	2	-12	-19
CP2 (2005) D	20	5	-3	-15	-22
CP2 (2005) C	13	-3	-6	-20	-32

Key:
AN = above-normal water
BN= below-normal water years
C = critical water years
CP = Comprehensive Plan
D = dry water years
NA = No-Action
W = wet water years
WSEL = water surface elevation

Figure 11-18. Average Monthly Change in Water Surface Elevation for Each Water Year Type Within the Shasta Lake Vicinity of the Primary Study Area, CP2 Compared with the Existing Condition



	Mar 31	Apr 30	May 31	Jun 30	Jul 31
NA W	8	16	5	-7	-15
NA AN	22	16	2	-13	-22
NA BN	16	15	1	-13	-21
NA D	21	6	-3	-15	-22
NA C	13	-2	-6	-21	-30
CP2 (2030) W	8	15	5	-6	-15
CP2 (2030) AN	22	15	3	-11	-20
CP2 (2030) BN	16	15	2	-13	-20
CP2 (2030) D	20	5	-3	-16	-22
CP2 (2030) C	13	-2	-6	-20	-31

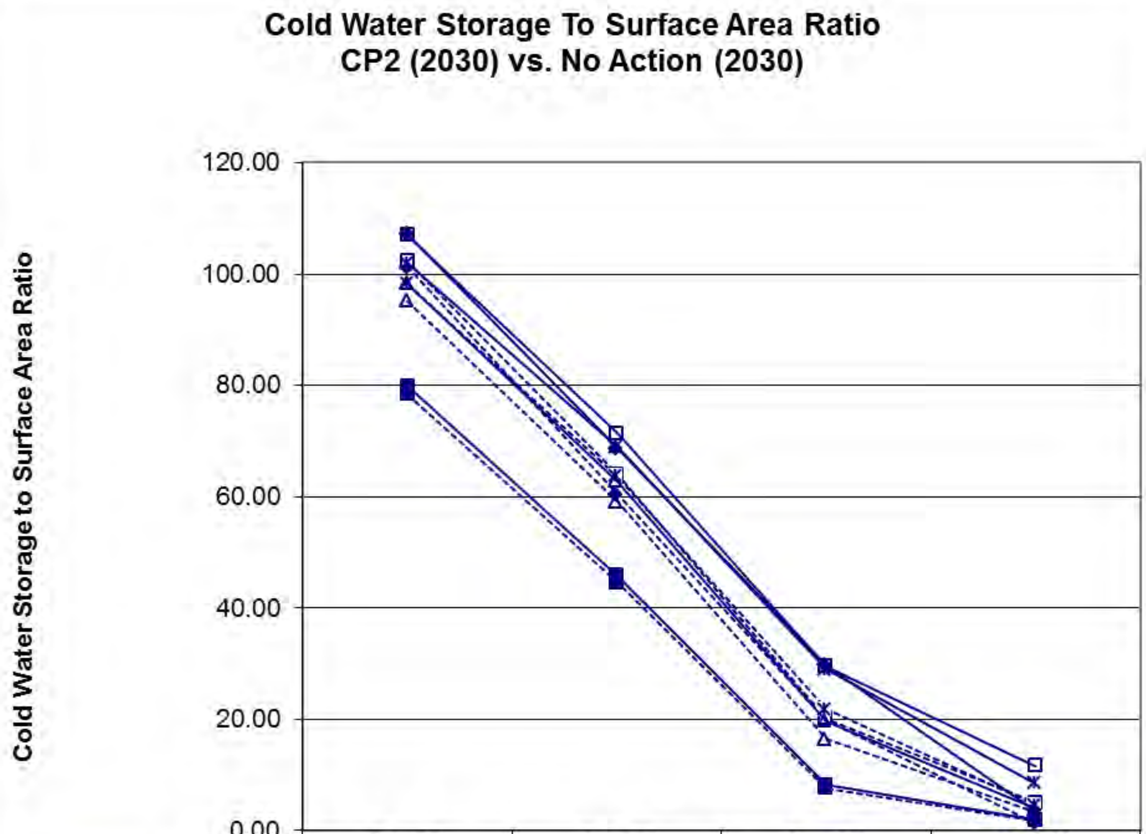
Key:
AN = above-normal water
BN= below-normal water years
C = critical water years
CP = Comprehensive Plan
D = dry water years
NA = No-Action
W = wet water years
WSEL = water surface elevation

Figure 11-19. Average Monthly Change in Water Surface Elevation for Each Water Year Type Within the Shasta Lake Vicinity of the Primary Study Area, CP2 Compared with No-Action

Impact Aqua-2 (CP2): Effects on Nearshore, Warm-Water Habitat in Shasta Lake from Project Construction Localized increases in soil erosion and resulting runoff sedimentation, and turbidity resulting from project construction in the vicinity of Shasta Dam and at utility, road, and other facility relocation areas could affect nearshore warm-water habitat. This impact would be similar to Impact Aqua-2 (CP1). However, CP2 would have a larger project footprint and would take longer to implement. However, the environmental commitments for all action would result in less-than-significant impacts. Mitigation for this impact is not needed, and thus not proposed.

Impact Aqua-3 (CP2): Effects on Cold-Water Habitat in Shasta Lake Under CP2, operations-related changes in the ratio of the volume of cold-water storage to surface area would increase the availability of suitable habitat for cold-water fish in Shasta Lake, including rainbow trout. This impact would be beneficial.

This impact would be similar to Impact Aqua-3 (CP1). However, it would be of greater magnitude owing to a greater increase in the ratio of the volume of cold-water storage in the lake to the surface area of the lake. CalSim-II modeling shows that under CP2 with a 2030 water supply demand, the ratio of cold-water storage to surface area is higher than under the No-Action Alternative in all water years and during all months modeled. The greatest projected increases over the No-Action Alternative occur between June 30 and August 31, which is a critical rearing and oversummering period for cold-water fishes in reservoirs, and the increases are greatest in wet and above-normal water years (Figure 11-20).



	Apr 30	Jun 30	Aug 31	Oct 31
NA W	101.33	60.49	19.89	1.43
NA AN	102.30	64.04	20.12	5.09
NA BN	98.27	63.71	21.84	4.64
NA D	95.13	59.14	16.50	3.38
NA C	78.43	44.58	7.66	1.82
CP2 2030 W	107.24	68.75	29.70	3.60
CP2 2030 AN	106.94	71.41	29.47	11.66
CP2 2030 BN	102.01	68.96	28.99	8.58
CP2 2030 D	98.28	62.83	19.64	3.90
CP2 2030 C	79.90	45.87	8.14	1.89

Key:
AN = above-normal water
BN= below-normal water years
C = critical water years
CP = Comprehensive Plan
D = dry water years
NA = No-Action
W = wet water years

Figure 11-20. Average Monthly Cold-water Storage to Surface Area Ratio for Each Water Year Type Within the Shasta Lake Vicinity of the Primary Study Area, CP2 Compared with the Existing Condition

CP2 would increase the availability of suitable habitat for cold-water fish in Shasta Lake, particularly in dry to wetter water year, with a slight improvement in critical years. Therefore, this impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Aqua-4 (CP2): Effects on Special-Status Aquatic Mollusks Under CP2, habitat for special-status mollusks could become inundated. Seasonal fluctuations in the surface area and WSEL of Shasta Lake could adversely affect special-status aquatic mollusks and their habitat in or near Shasta Lake and its tributaries. This impact would be similar to Impact Aqua-4 (CP1). However, a larger area would be inundated under CP2, which could result in an increase in impacts to these species and their habitat. Except for the California floater, the occurrence of special-status mollusks in Shasta Lake and the lower reaches of its tributaries is unlikely. Modification or loss of suitable habitat for the California floater would occur through increased WSEL and seasonal fluctuations in the surface area under CP2. Therefore, this impact would be potentially significant. Mitigation for this impact is proposed in Section 11.3.4, "Mitigation Measures."

Impact Aqua-5 (CP2): Effects on Special-Status Fish Species The expansion of the surface area of Shasta Lake and the inundation of additional tributary habitat under CP2 could affect one species designated as sensitive by USFS, the hardhead. However, available data suggest that hardhead do not currently occur or are very uncommon in the primary tributaries to Shasta Lake, other than the Pit River above the Pit 7 Afterbay.

The 14.5-foot increase in full pool elevation of Shasta Lake would inundate partial or complete fish passage barriers in approximately 68 perennial and 400 intermittent tributaries (greater than 98 percent of which are non-fish-bearing), including the 15-foot high cascade in Squaw Creek that could expand access to Squaw Creek for hardhead; expanded access could be locally beneficial to this special-status species, although the increase may also permit access by predatory warm-water fishes. Access to, and the availability of, suitable riverine habitat among all the main tributaries to the reservoir would not likely become any more limiting than under current conditions, nor would it greatly expand. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Aqua-6 (CP2): Creation or Removal of Barriers to Fish Between Tributaries and Shasta Lake Under CP2, project implementation would result in the periodic inundation of steep and low-gradient tributaries to Shasta Lake up to the 1,084-foot contour, the maximum inundation level under this alternative. This impact would be less than significant.

This impact would be similar to Impact Aqua-6 (CP1) (i.e., creation and elimination of fish passage barriers in tributaries to Shasta Lake would primarily be limited to non-fish-bearing intermittent streams). However, the maximum inundation level would be higher under CP2, which would inundate (eliminate) partial or complete fish barriers in approximately 34 perennial tributaries, only 15 of which have complete barriers, and the most important of which is a 15-foot boulder cascade in Squaw Creek. Potential impacts of reservoir enlargement to fish communities above passage barriers would be greatest among perennial tributaries as the proportion of fish-bearing perennial streams (87 percent) is much greater than for intermittent streams (2 percent). This could have a small and localized beneficial effect for adfluvial cold-water fish in Shasta Lake by increasing the amount of suitable spawning and rearing habitat available to these species.

Conversely, the potential for access of warm-water fish species into some tributaries, with a potential to alter existing resident fish communities, would be extended by inundation of passage barriers under CP2. However, except for the main river tributaries (i.e., Sacramento, Pit, and McCloud rivers), less than 10 percent of the lake's other accessible tributaries have been found to be colonized by warm-water fish above the varial zone and any further access is expected to be limited primarily to the newly inundated reaches of some streams.

CP2 would not result in the widespread c*reation or elimination of fish passage barriers in tributaries to Shasta Lake. One exception is Squaw Creek, where inundation of a barrier at the current head of the reservoir would potentially allow warm-water fish to move upstream and colonize previously inaccessible habitat with consequent effects on the native fish community and sensitive invertebrates (e.g., mollusks). Environmental commitments, described in Chapter 2, "Alternatives," to monitor fish communities in Squaw Creek and adaptively manage to prevent warmwater fish invasions would reduce this impact to a less than significant level.* Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Aqua-7 (CP2): Effects on Spawning and Rearing Habitat of Adfluvial Salmonids in Low-Gradient Tributaries to Shasta Lake Similar to CP1, CP2 would result in additional periodic inundation of potential spawning and rearing habitat for adfluvial salmonids in low-gradient tributaries. In addition to modification of the hydraulic regimes of these affected reaches, changes in the WSEL as a result of CP2 will affect the character and location of substrate (e.g., spawning gravel) at some locations, thereby influencing the suitability.

As described in Chapter 4, "Geology, Geomorphology, Minerals, and Soils," CP2 would inundate perennial reaches with gradients of less than 7 percent that could provide potentially suitable spawning and rearing habitat for adfluvial salmonids. The lengths of low-gradient tributaries to each arm of Shasta Lake and estimated suitable spawning habitat areas (both intermittent and perennial) that would be periodically affected are as follows:

- Sacramento Arm – 3.1 miles (16,430 Square feet, excludes mainstem river)
- McCloud Arm – 1.4 miles (9,990 square feet)
- Pit Arm – 1.4 miles (523 square feet, excludes mainstem river)
- Big Backbone Arm – 0.6 miles (144 square feet)
- Squaw Arm – 0.9 miles (1,300 square feet)

A total of 7.4 miles of low-gradient reaches (based on channel slope and confirmed by surveys of representative stream reaches) that could provide some spawning and rearing habitat for adfluvial salmonids (estimated as 31,500 square feet for all tributaries) would be affected by CP2, which is only about 1.8 percent of the low-gradient habitat upstream from Shasta Lake. An additional 8,285 square feet of suitable cold-water spawning habitat is estimated to be periodically inundated under CP2 compared to CP1. Therefore, this impact would be potentially significant. Mitigation for this impact is proposed in Section 11.3.4, "Mitigation Measures."

Impact Aqua-8 (CP2): Effects on Aquatic Connectivity in Non-Fish-Bearing Tributaries to Shasta Lake CP2 would result in periodic inundation of the lower reaches of high-gradient, intermittent non-fish-bearing tributaries to Shasta Lake. About 17.3 miles of non-fish-bearing tributary habitat (based on channel slope and confirmed by surveys of representative stream reaches) would be affected by CP2, which is only about 0.7 percent of this habitat upstream from Shasta Lake.

As described in Chapter 4, "Geology, Geomorphology, Minerals, and Soils," CP2 would inundate tributary segments with channel slopes in excess of 7 percent. Although these segments do not typically support salmonid populations, they do provide riparian and aquatic habitat for a variety of organisms and serve as corridors that connect habitat types. The lengths of non-fish-bearing tributaries for each arm of Shasta Lake that would be periodically inundated are as follows:

- Sacramento Arm – 3.9 miles
- McCloud Arm – 2.8 miles
- Pit Arm – 2.5 miles
- Big Backbone Arm – 1.8 miles
- Squaw Arm – 1.3 miles

- Main Body – 5.0 miles

This impact would be similar to Impact Aqua-8 (CP1). However, it would periodically inundate a larger amount of habitat in low-gradient reaches to Shasta Lake, but the total amount inundated would be only 0.7 percent of the non-fish-bearing tributary habitat (based on channel slope) upstream from the lake and no special-status aquatic vertebrate or invertebrate species have been detected in these reaches. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Aqua-9 (CP2): Effects on Water Quality at Livingston Stone Hatchery Reclamation provides the water supply to the Livingston Stone Hatchery from a pipeline emanating from Shasta Dam. This supply would not be interrupted by any activity associated with CP2. There would be no impact.

This impact is the same as Impact Aqua-9 (CP1) and there would be no impact. Mitigation for this impact is not needed, and thus not proposed.

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact Aqua-10 (CP2): Loss or Degradation of Aquatic Habitat in the Upper Sacramento River During Construction Activities Temporary construction-related increases in sediments and turbidity levels would adversely affect aquatic habitats and fish populations immediately downstream in the upper Sacramento River. However, environmental commitments would be in place to reduce the effects. This impact would be less than significant.

This impact would be similar to Impact Aqua-10 (CP1). The impact could be greater under CP2 than under CP1 because of the increased activity associated with a 12.5-foot raise compared to a 6.5-foot raise. However, as under CP1, environmental commitments for all actions would be in place to reduce the effects. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Aqua-11 (CP2): Release and Exposure of Contaminants in the Upper Sacramento River During Construction Activities Construction-related activities could result in the release and exposure of contaminants. Such exposure could adversely affect aquatic habitats, the aquatic food web, and fish populations, including special-status species, downstream in the primary study area. However, environmental commitments would be in place to reduce the effects. Therefore, this impact would be less than significant.

This impact would be similar to Impact Aqua-11 (CP1). The impact could be greater under CP2 than under CP1 because of the increased activity associated with a 12.5-foot raise compared to a 6.5-foot raise. A potential release of hazardous materials into the upper Sacramento River could cause a reduction in aquatic habitats and fish populations if proper procedures were not implemented to contain the discharge. However, as under CP1, environmental commitments for all actions would be in place to reduce the effects. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Aqua-12 (CP2): Changes in Flow and Water Temperature in the Upper Sacramento River Resulting from Project Operation – Chinook Salmon and Steelhead CP2 operation under CP2 would generally result in improved flow and water temperature conditions in the upper Sacramento River for Chinook salmon and steelhead, but not all runs have an increase in production. This impact would be beneficial.

Winter-Run Chinook Salmon

Production

The overall average winter-run production for the 81-year period was similar for CP2 relative to the No-Action Alternative and the Existing Condition (Attachments 3 and 4 of the Modeling Appendix). The maximum increase in production relative to the No-Action Alternative was 61 percent in a critical water year for CP2, while the largest decrease in production relative to the No-Action Alternative was around 24 percent, also in a critical water year (Table 11-19 and Attachment 3 of the Modeling Appendix). The maximum increase in production relative to the Existing Condition was 45 percent for CP2, while the largest decrease in production relative to the Existing Condition was around 27 percent under CP2 (Table 11-19 and Attachment 4 of the Modeling Appendix). Figure 11-9 shows the change in production relative to the No-Action Alternative for all water years and all Comprehensive Plans.

Under CP2, only two critical water years had significant increases (greater than 5 percent) in production relative to the No-Action Alternative for winter-run Chinook salmon. No other water year type had a significant increase in production. One critical water year had a significant decrease in production.

Under CP2, four critical, one dry water, and one below-normal water years had significant increases in production relative to the Existing Condition for winter-run Chinook salmon. Three years (one each in critical, dry and above-normal water year types) had significant decreases in production greater than 5 percent.

Table 11-19. Change in Production Under CP2 for Winter-Run Chinook Salmon

Year Type	Number of Years	Average Production	Change in Production from Baseline	Percent Change in Average Production	Maximum Percent Increase in Production	Number of Years with Significant Increase	Maximum Percent Decrease in Production	Number of Years with Significant Decrease
Future Condition (2030)								
All	81	3,772,931	-28,184	-0.7	61.1	2	-23.8	1
Critical	13	3,343,654	-34,302	-1.0	61.1	2	-23.8	1
Dry	17	3,953,711	-18,620	-0.5	2.9	0	-2.9	0
Below Normal	14	3,941,590	3,032	0.1	3.6	0	-2.6	0
Above Normal	11	3,799,691	-59,239	-1.5	0.5	0	-4.7	0
Wet	26	3,767,230	-35,048	-0.9	4.4	0	-3.9	0
Existing Condition (2005)								
All	81	3,776,950	-4,297	-0.1	44.5	6	-5.8	2
Critical	13	3,357,691	146,752	4.6	44.5	4	-5.6	1
Dry	17	3,965,107	-18,754	-0.5	15.2	1	-5.0	0
Below Normal	14	3,941,118	968	0.0	5.2	1	-4.4	0
Above Normal	11	3,782,121	-70,562	-1.8	2.3	0	-5.8	1
Wet	26	3,772,968	-45,168	-1.2	1.5	0	-4.4	0

Note:

Production is the number of immature smolts surviving to pass the Red Bluff Pumping Plant

Mortality

Mortality was separated by flow- and water temperature-related mortality to assess the level of impacts on winter-run Chinook salmon caused by the actions of the project (Attachments 3 and 4). Nonoperations-related mortality are the base and seasonal mortality that would occur even without the effects of Shasta operations (such as disease, predation, and entrainment). Flow- and water temperature-related mortality is that caused by altering flow and water temperatures. In all cases, most mortality is caused by nonoperations-related factors (e.g., disease, predation, entrainment)−around 86 percent of the total mortality.

Mortality is presented in two manners–total mortality and smolt equivalent mortality (Attachments 3 and 4 of the Modeling Appendix). The greatest average mortality to winter-run Chinook salmon under CP1 in all water year types based on smolt equivalents would occur to the fry life stage, followed by eggs, then presmolts, and lastly immature smolts. Table 11-5 displays the overall mortalities for each Comprehensive Plan that were caused by changes in water temperature and flow) (Attachments 3 and 4 of the Modeling Appendix).

Years with the highest flow- and water temperature-related mortality were the same for the No-Action Alternative, the Existing Condition, and CP2. Each of these years was a critical water year, and was preceded by either a critical (1933, 1976, 1991), or dry (1930, 1932) water year type. Years with the lowest mortality varied between all water year types. Years in which the project has the greatest effect on winter-run were also years in which the lowest production occurred (Attachments 3 and 4).

Although winter-run Chinook salmon have, under both 2030 and 2005 conditions, an insignificant change in productivity, there is a decrease in project-related mortality under 2005 conditions (4.4 percent) and an increase in project-related mortality under 2030 conditions (0.9 percent). Additionally, there would not be a significant improvement in production during critical water years. Therefore, the actions taken in CP2 would result in less-than-significant impacts to winter-run Chinook salmon under both 2030 and 2005 conditions. Mitigation for this impact is not needed, and thus not proposed.

Spring-Run Chinook Salmon

Production

The overall 81-year average production for spring-run Chinook salmon under CP2 is insignificantly higher relative to the No-Action Alternative and insignificantly lower than the Existing Condition (Attachments 6 and 7 of the Modeling Appendix). The maximum increase in production relative to the No-Action Alternative was 97 percent in a critical water year for CP2, while the largest decrease in production relative to the No-Action Alternative was -17 percent, also in a critical water year (Table 11-20 and Attachment 6 of the Modeling Appendix). The maximum increase in production relative to the Existing Condition was 375 percent for CP2 and the largest decrease in production was less than -5 percent under CP2 in 1977 (Table 11-20 and Attachment 7 of the Modeling Appendix). Figure 11-10 shows the change in production relative to the No-Action Alternative for all water years and all Comprehensive Plans.

Under CP2, five critical, two dry, and one below-normal water years had significant increases in production relative to the No-Action Alternative. Production significantly decreased in five critical water years (between -11 and -17 percent). No other water year type had a significant decrease in production.

Under CP2, nine critical, two dry, and one below-normal water years had significant increases in production relative to the Existing Condition. No water years had significant decrease in production relative to the Existing Condition.

Table 11-20. Change in Production Under CP2 for Spring-Run Chinook Salmon

Year Type	Number of Years	Average Production	Change in Production from Baseline	Percent Change in Average Production	Maximum Percent Increase in Production	Number of Years with Significant Increase	Maximum Percent Decrease in Production	Number of Years with Significant Decrease
Future Condition (2030)								
All	81	164,655	601	0.4	97.4	8	-17.4	5
Critical	13	87,341	6,152	7.6	97.4	5	-17.4	5
Dry	17	171,229	1,777	1.0	96.7	2	-1.7	0
Below Normal	14	177,935	754	0.4	21.1	1	-3.8	0
Above Normal	11	182,449	-1,317	-0.7	4.2	0	-2.9	0
Wet	26	184,335	-2,215	-1.2	1.6	0	-3.9	0
Existing Condition (2005)								
All	81	165,357	2,149	1.3	375	12	-4.2	0
Critical	13	89,925	15,863	21.4	151	9	-4.2	0
Dry	17	171,694	2,833	1.7	375	2	-2.4	0
Below Normal	14	178,901	872	0.5	29.6	1	-2.5	0
Above Normal	11	182,404	-1,709	-0.9	3.3	0	-2.8	0
Wet	26	184,424	-2,834	-1.5	1.9	0	-4.2	0

Note:

Production is the number of immature smolts surviving to pass the Red Bluff Pumping Plant

Mortality

Mortality was separated by flow- and water temperature-related mortality to assess the level of impacts on spring-run Chinook salmon caused by the actions of the project (Attachments 6 and 7 of the Modeling Appendix). In all cases, most mortality is caused by nonoperations-related factors (e.g., disease, predation, entrainment)−around 83 percent of the total mortality.

Mortality is presented in two manners–total mortality and smolt equivalent mortality (Attachments 6 and 7 of the Modeling Appendix). Under both 2030 and 2005 conditions, the greatest mortality to spring-run Chinook salmon under CP2 (as with CP1) in all water year types based on smolt equivalents would occur to eggs, with minimal mortality to the other life stages. Table 11-7 displays the smolt-equivalent mortalities for each Comprehensive Plan that are caused by flow- and water-related factors (also see Attachments 6 and 7 of the Modeling Appendix).

Years with the highest flow- and water temperature-related mortality were the same for the No-Action Alternative, the Existing Condition, and CP2. Except for 1932 (a dry water year), each of these years was a critical water year type and was preceded by either a below, dry, or (predominantly) a critical water year. However, years with the lowest mortality varied between all water year types (Attachments 6 and 7 of the Modeling Appendix).

Under both 2030 and 2005 conditions, spring-run Chinook salmon would experience a significant reduction in flow- and water temperature-related mortality, but an insignificant increase in overall production. However, spring-run would experience a significant increase in production overall for critical water years, especially in years in which the spring-run Chinook salmon could be extirpated from the Sacramento River due to such a low number of fish surviving to pass RBPP. Therefore, spring-run Chinook salmon would benefit from actions taken in CP2. Mitigation for this impact is not needed, and thus not proposed.

Fall-Run Chinook Salmon

Production

Overall average fall-run Chinook salmon production for the simulation period was slightly higher for CP2 than for either the No-Action Alternative or Existing Condition (Attachments 9 and 10 of the Modeling Appendix). The maximum increase in production relative to the No-Action Alternative was 44 percent for CP2 in a critical water year, while the largest decrease in production relative to the No-Action Alternative was -6 percent, also in a critical water year (Table 11-21 and Attachment 9 of the Modeling Appendix). The maximum increase in production relative to the Existing Condition was 47 percent for CP2, and the largest decrease in production was around -27 percent under CP2 (Table 11-21 and Attachment 10 of the Modeling Appendix). Figure 11-11 shows the annual change in production relative to the No-Action Alternative for all Comprehensive Plans.

Table 11-21. Change in Production Under CP2 for Fall-Run Chinook Salmon

Year Type	Number of Years	Average Production	Change in Production from Baseline	Percent Change in Average Production	Maximum Percent Increase in Production	Number of Years with Significant Increase	Maximum Percent Decrease in Production	Number of Years with Significant Decrease
No-Action Alternative (2030)								
All	81	29,926,852	408,446	1.4	44.0	10	-6.0	1
Critical	13	27,955,633	1,510,805	5.7	44.0	4	-1.4	0
Dry	17	30,244,797	704,637	2.4	18.4	3	-1.7	0
Below Normal	14	31,488,759	390,848	1.3	22.1	2	-4.4	0
Above Normal	11	31,022,573	-10,437	0.0	4.9	0	-3.4	0
Wet	26	29,399,974	-149,702	-0.5	7.2	1	-6.0	1
Existing Condition (2005)								
All	81	29,770,129	341,787	1.2	47.4	10	-26.8	3
Critical	13	27,223,572	1,047,436	4.0	47.4	3	-26.8	1
Dry	17	30,168,009	707,608	2.4	27.5	5	-2.9	0
Below Normal	14	31,401,051	382,789	1.2	36.4	2	-6.0	1
Above Normal	11	30,916,415	46,018	0.1	2.7	0	-2.8	0
Wet	26	29,420,098	-147,172	-0.5	4.3	0	-6.4	1

Note:

Production is the number of immature smolts surviving to pass the Red Bluff Pumping Plant

Except for 1977, in critical, dry, and below-normal water years, when production was lowest over the simulation period, the increase in production resulting from operations-related activities was greatest. In wet water years, however, the lowest production years typically had a slight decrease in production under CP2 conditions relative to the No-Action Alternative.

Under CP2, four critical, three dry, two below-normal, and one wet water year had significant increases in production relative to the No-Action Alternative. Only one year (1969) out of the 81 simulated years had a significant decrease in production (Table 11-21).

Under CP2, three critical, five dry, and two below-normal water years had significant increases in production relative to the Existing Condition. One critical (1977), one below-normal (1979), and one wet (1969) water years resulted in significantly decreased production relative to the Existing Condition (Table 11-21).

Mortality

Mortality was separated by flow- and water temperature-related mortality to assess the level of impacts on fall-run Chinook salmon caused by the actions of the project (Attachments 9 and 10). In all cases, most mortality is caused by nonoperations-related factors (e.g., disease, predation, entrainment)−around 65 percent of the total mortality.

Under both 2030 and 2005 conditions, the greatest mortality to fall-run Chinook salmon under CP2 (as with CP1) in all water year types based on smolt equivalents would occur to fry, then to eggs, prespawn adults, presmolts and then immature smolts. Table 11-9 displays the overall mortalities for each alternative that would be caused by flow and water temperature changes (Attachments 9 and 10 of the Modeling Appendix). Mortalities caused by operations-related activities would be lower for CP2 than for the No-Action Alternative (Table 11-9).

There was no real trend with respect to water year type with the greatest mortality.

Fall-run Chinook salmon have an insignificant increase in production and an insignificant reduction in project-related mortality, but would have a significant increase in production overall during critical water years. However, the fall-run Chinook salmon would benefit from actions taken in CP2. Mitigation for this impact is not needed, and thus not proposed.

Late Fall-Run Chinook Salmon

Late fall-run Chinook salmon were evaluated directly using SALMOD and were considered to be a surrogate for steelhead; therefore, the following discussion regarding SALMOD results for late fall-run Chinook salmon are applicable to steelhead.

Production

Overall average late fall-run Chinook salmon production for the 80-year period was similar (less than 5 percent change) for CP2 relative to the No-Action Alternative and the Existing Condition (Attachments 12 and 13 of the Modeling Appendix). The maximum increase in production relative to the No-Action Alternative was almost 9 percent for CP2 in a dry water year, while the greatest decrease in production relative to the No-Action Alternative was -5 percent in a critical water year (Table 11-22 and Attachment 12 of the Modeling Appendix).

The maximum increase in production relative to the Existing Condition was 12 percent for CP2 in 1985. The largest decrease in production relative to the Existing Condition was less than almost -7 percent under CP2 (Table 11-22 and Attachment 13 of the Modeling Appendix). Figure 11-12 shows the change in production relative to the No-Action Alternative for all water years and all Comprehensive Plans.

Under CP2, production significantly (greater than 5 percent) increased for two critical and two dry water years, while two critical water years had significant decreases in production relative to the No-Action Alternative.

Table 11-22. Change in Production Under CP2 for Late Fall-Run Chinook Salmon

Year Type	Number of Years	Average Production	Change in Production from Baseline	Percent Change in Average Production	Maximum Percent Increase in Production	Number of Years with Significant Increase	Maximum Percent Decrease in Production	Number of Years with Significant Decrease
Future Condition (2030)								
All	80	7,416,831	-1,656	0.0	8.7	3	-5.1	1
Critical	13	7,044,042	-20,127	-0.3	5.9	2	-5.1	1
Dry	16	7,429,076	74,707	1.0	8.7	1	-3.2	0
Below Normal	14	7,588,598	-24,020	-0.3	1.6	0	-3.4	0
Above Normal	11	7,574,775	-11,309	-0.1	3.6	0	-2.6	0
Wet	26	7,436,378	-23,286	-0.3	4.3	0	-2.9	0
Existing Condition (2005)								
All	80	7,445,153	58,592	0.8	12.3	4	-6.6	1
Critical	13	7,058,132	94,836	1.4	8.6	1	-2.2	0
Dry	16	7,498,737	138,469	1.9	12.3	3	-3.4	0
Below Normal	14	7,657,874	46,780	0.6	3.2	0	-2.3	0
Above Normal	11	7,616,470	56,796	0.8	2.6	0	-2.3	0
Wet	26	7,418,665	-1,566	0.0	3.5	0	-6.6	1

Notes:

Production is the number of immature smolts surviving to pass the Red Bluff Pumping Plant

Late fall-run Chinook salmon are used as a surrogate for steelhead

Under CP2 compared with the Existing Condition, one critical and three dry water years had significant increases in production. One wet water year had a significant (greater than 5 percent) decreases in production.

Mortality

Mortality was separated by flow- and water temperature-related mortality to assess the level of impacts on late fall-run Chinook salmon caused by the actions of the project (Attachments 12 and 13). In all cases, most mortality is caused by nonoperations-related factors (e.g., disease, predation, entrainment)–around 78 percent of the total mortality.

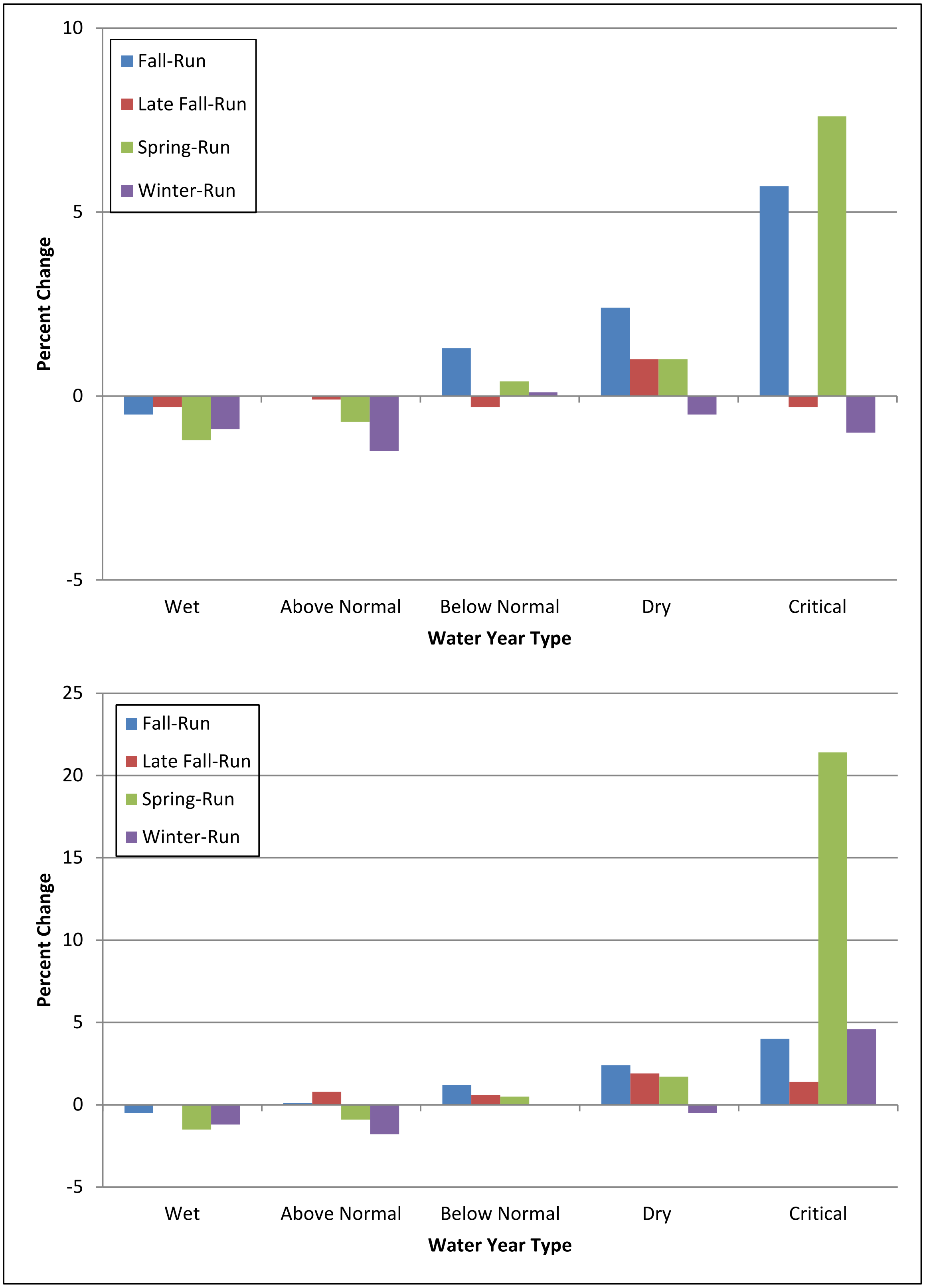
Under both 2030 and 2005 conditions, the greatest mortality to late fall-run Chinook salmon under CP2 (as with CP1) in all water year types based on smolt equivalents would occur to fry, then eggs, presmolts, immature smolts, and lastly to prespawn adults. Table 11-11 displays overall mortalities for each Comprehensive Plan that would be caused by changes in flow and water temperature (see also Attachments 12 and 13 of the Modeling Appendix).

Years with the highest operations-related mortality would be the same for CP2, the No-Action Alternative, and Existing Condition. All water year types were covered. Three years were preceded by a wet water year, and one preceded by an above-normal water year (Attachments 12 and 13 of the Modeling Appendix).

Because SALMOD indicates an insignificant change in mortality and production index for late fall-run Chinook salmon, late fall-run Chinook salmon and steelhead (as represented by late fall-run Chinook salmon as their surrogate) would experience a less-than-significant impact from actions taken in CP2. Mitigation for this impact is not needed, and thus not proposed.

All Chinook Runs Combined

Raising Shasta Dam by 12.5 feet, in conjunction with spillway modifications, would result in an increase in full pool depth of 14.5 feet and an additional 443,000 acre-feet of storage capacity in Shasta Reservoir. The additional storage created by the dam raise would be used to improve the ability to meet water temperature objectives and habitat requirements for anadromous fish during drought years (see Figure 11-21). Under the 2030 conditions, overall production for all four runs of Chinook salmon combined would increase by over 379,000 immature smolts migrating below RDPP. Under the 2005 conditions, overall production for all four runs of Chinook salmon combined would increase by over 398,000 immature smolts migrating below RDPP.



Note: Changes in outmigrating Chinook salmon simulated using SALMOD; Water Year Types based on the Sacramento Valley Water Year Hydrologic Classification

Figure 11-21. Percent Change in Production of Chinook Salmon for CP2 Compared to the No-Action Alternative (top) and Existing Conditions (bottom)

Impact Aqua-13 (CP2): Changes in Flow and Water Temperatures in the Upper Sacramento River Resulting from Project Operation – Steelhead, Green Sturgeon, Sacramento Splittail, American Shad, and Striped Bass Project operation generally would result in slightly improved flow and water temperature conditions in the upper Sacramento River for steelhead, green sturgeon, Sacramento splittail, American shad, and striped bass. This impact would be less than significant.

This impact would be similar to Impact Aqua-13 (CP1). The impact could be greater under CP2 than under CP1 because the increased reservoir capacity associated with a 12.5-foot raise compared to a 6.5-foot raise would allow storage of additional water volume (and flows) behind the raised dam.

Flow-Related Effects As under CP1, monthly mean flows at all modeling locations along the upper Sacramento River (below Shasta Dam, below Keswick Dam, above Bend Bridge, and above RBPP) under CP2 would generally be equivalent to (less than 2-percent difference from, with more increases than decreases) flows under the Existing Condition and No-Action Alternative simulated for all months. (See the Modeling Appendix for complete modeling results.)

Potential flow-related effects of CP2 on fish species of management concern in the upper Sacramento River would be minimal. Potential changes in flows and stages would diminish rapidly downstream from RBPP because of increased effects from tributary inflows, diversions, and flood bypasses.

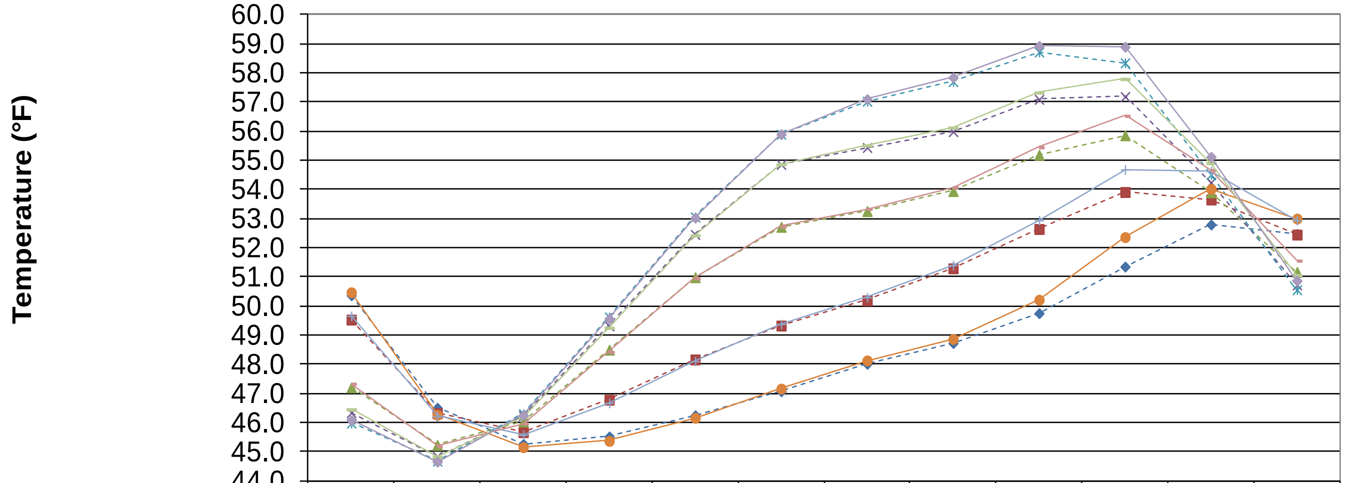
Changes in monthly mean flows under CP2 relative to the Existing Condition and No-Action Alternative would have no discernible effects on steelhead, green sturgeon, Sacramento splittail, American shad, or striped bass in the upper Sacramento River. Functional flows for migration, attraction, spawning, egg incubation, and rearing/emigration for these species would be unchanged. Therefore, flow-related impacts on these fish species would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Water Temperature–Related Effects As under CP1, monthly mean water temperatures at all modeling locations along the upper Sacramento River (below Shasta Dam, below Keswick Dam, Balls Ferry, above Bend Bridge, and above RBPP) under CP2 would be the same as, or fractionally less than, water temperatures under the Existing Condition and No-Action Alternative simulated for all months (Figures 11-22 and 11-23). (See the Modeling Appendix for complete modeling results.)

As discussed above, the modeling simulations may not fully account for real-time management of the cold-water pool and TCD (through the SRTTG) to achieve maximum cold-water benefits. Therefore, the modeled changes in water temperature (i.e., small benefits) are likely conservative and understated to some varying degree. Potential water temperature-related effects of CP2 on fish species of management concern in the upper Sacramento River would be minimal. During most years, releases from Shasta Lake would be unchanged.

The slightly cooler monthly mean water temperatures under CP2 relative to the Existing Condition and the No-Action Alternative would have very small effects on steelhead, green sturgeon, Sacramento splittail, American shad, or striped bass in the upper Sacramento River. Monthly mean water temperatures would not rise above important thermal tolerances for the species life stages relevant to the upper Sacramento River. Therefore, water temperature–related impacts on these fish species would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CP2 vs Existing Condition (2005)

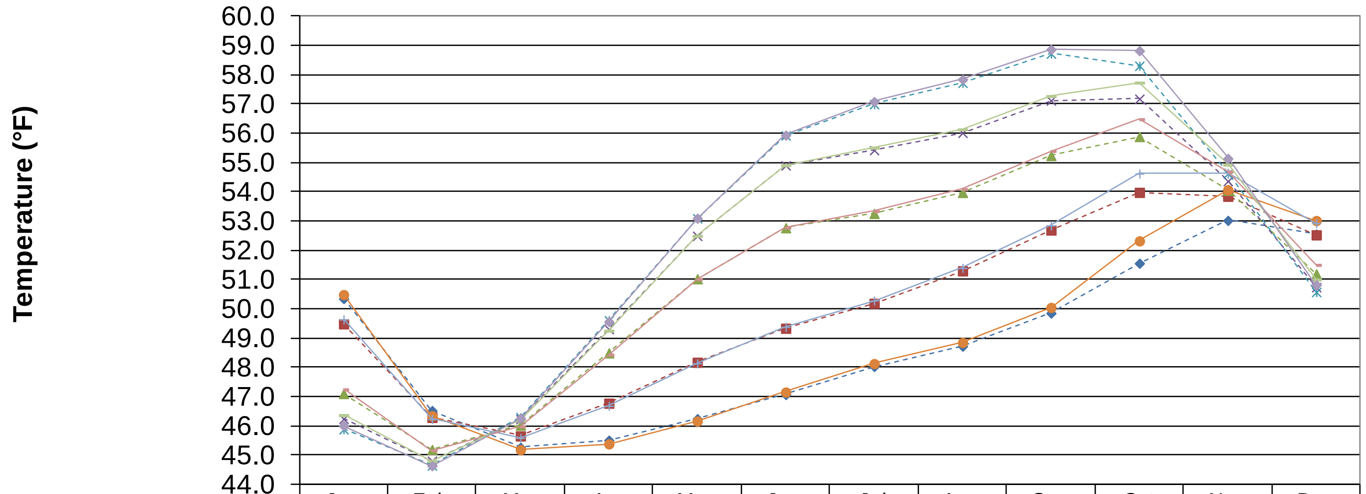


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CP2 Below Shasta	50.4	46.5	45.3	45.5	46.3	47.1	48.0	48.7	49.8	51.4	52.8	52.5
CP2 Below Keswick	49.5	46.3	45.7	46.8	48.2	49.3	50.2	51.3	52.6	53.9	53.7	52.5
CP2 Balls Ferry	47.2	45.2	46.0	48.5	51.0	52.7	53.3	53.9	55.2	55.9	53.9	51.2
CP2 Bend Bridge	46.3	44.8	46.2	49.3	52.5	54.9	55.4	56.0	57.1	57.2	54.2	50.7
CP2 RBPP	46.0	44.7	46.3	49.6	53.1	55.9	57.0	57.7	58.7	58.3	54.5	50.6
EC Below Shasta	50.5	46.3	45.2	45.4	46.2	47.2	48.1	48.9	50.2	52.4	54.0	53.0
EC Below Keswick	49.7	46.2	45.6	46.7	48.1	49.4	50.3	51.4	52.9	54.7	54.6	52.9
EC Balls Ferry	47.3	45.2	46.0	48.4	50.9	52.7	53.3	54.1	55.4	56.5	54.7	51.6
EC Bend Bridge	46.5	44.8	46.2	49.3	52.4	54.9	55.5	56.1	57.3	57.8	54.9	51.1
EC RBPP	46.1	44.7	46.3	49.6	53.0	55.9	57.1	57.8	58.9	58.9	55.1	50.9

Key: °F = degrees Fahrenheit EC = Existing Condition
CP = Comprehensive Plan RBPP = Red Bluff Pumping Plant

Figure 11-22. Changes in Mean Monthly Water Temperature at Modeled Locations in the Sacramento River Within the Primary Study Area (CP2 Versus the Existing Condition)

CP2 vs No-Action (2030)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CP2 Below Shasta	50.4	46.5	45.3	45.5	46.2	47.1	48.0	48.7	49.9	51.6	53.0	52.6
CP2 Below Keswick	49.5	46.3	45.7	46.8	48.2	49.3	50.2	51.3	52.7	54.0	53.8	52.5
CP2 Balls Ferry	47.1	45.2	46.0	48.5	51.0	52.8	53.3	54.0	55.2	55.9	54.0	51.2
CP2 Bend Bridge	46.2	44.8	46.2	49.3	52.5	54.9	55.4	56.0	57.1	57.2	54.4	50.7
CP2 RBPP	45.9	44.7	46.3	49.6	53.1	55.9	57.0	57.7	58.7	58.3	54.6	50.6
NA Below Shasta	50.5	46.3	45.2	45.4	46.2	47.2	48.1	48.9	50.0	52.3	54.1	53.0
NA Below Keswick	49.6	46.2	45.6	46.7	48.1	49.4	50.3	51.4	52.9	54.6	54.6	52.9
NA Balls Ferry	47.3	45.2	46.0	48.4	51.0	52.8	53.3	54.1	55.4	56.5	54.7	51.5
NA Bend Bridge	46.4	44.8	46.2	49.3	52.5	54.9	55.5	56.1	57.3	57.7	54.9	51.0
NA RBPP	46.0	44.6	46.3	49.6	53.1	55.9	57.1	57.8	58.9	58.8	55.1	50.8

Key: °F = degrees Fahrenheit NA = No-Action Alternative
CP = Comprehensive Plan RBPP = Red Bluff Pumping Plant

Figure 11-23. Changes in Mean Monthly Water Temperature at Modeled Locations in the Sacramento River Within the Primary Study Area (CP2 Versus No-Action Alternative)

Impact Aqua-14 (CP2): Reduction in Ecologically Important Geomorphic Processes in the Upper Sacramento River Resulting from Reduced Frequency and Magnitude of Intermediate to High Flows Project operations could cause a reduction in the magnitude, duration, and frequency of intermediate to large flows both in the upper Sacramento River and in the lowermost (confluence) areas of tributaries. Such flows are necessary for channel forming and maintenance, meander migration, and creation of seasonally inundated floodplains. These geomorphic processes are ecologically important because they are needed to maintain important aquatic habitat functions and values for fish and macroinvertebrate communities. This impact would be potentially significant.

This impact would be similar to Impact Aqua-14 (CP1). The impact could be greater under CP2 than under CP1 because the increased reservoir capacity associated with a 12.5-foot raise compared to a 6.5-foot raise would allow for storage of additional water volume (and flows) behind the raised dam.

Sediment transport, deposition, and scour regulate the formation of key habitat features such as point bars, gravel deposits, and SRA habitat. Intermediate to high flows and the associated stage elevation of the river surface also provide a backwater effect on the lowermost segment of tributaries, reducing the potential for downcutting. These processes are regulated by the magnitude and frequency of flow. Relatively large floods provide the energy required to mobilize sediment from the riverbed, produce meander migration, increase stage elevation, and create seasonally inundated floodplains. Operations under CP2 could result in a reduction in the intermediate to large flows necessary for channel forming and maintenance, meander migration, and creation of seasonally inundated floodplains.

Implementation of CP2 would cause a further reduction in the magnitude, duration, and frequency of intermediate to large flows, relative to the Existing Condition and No-Action Alternative. Overall, the project would increase the existing, ongoing effects on geomorphic processes resulting from the operation of Shasta Dam that are necessary for channel forming and maintenance, meander migration, and creation of seasonally inundated floodplains. These effects would likely occur throughout the upper Sacramento River portion of the primary study area.

Reductions in the magnitude of high flows would likely be sufficient to reduce ecologically important processes along the upper Sacramento River. This impact would be potentially significant. Mitigation for this impact is proposed in Section 11.3.4, “Mitigation Measures.”

Lower Sacramento River and Delta

Impact Aqua-15 (CP2): Changes in Flow and Water Temperatures in the Lower Sacramento River and Tributaries and Trinity River Resulting from Project

Operation – Fish Species of Primary Management Concern Project operation would result in no discernible change in monthly mean flows or water temperature conditions in the lower Sacramento River. However, predicted changes in flows in the Feather, American, and Trinity rivers could result in adverse effects on Chinook salmon, steelhead, Coho salmon, green sturgeon, Sacramento splittail, American shad, and striped bass. This impact would be potentially significant.

This impact would be similar to Impact Aqua-15 (CP1). The impact could be greater under CP2 than under CP1 because the increased reservoir capacity associated with a 12.5-foot raise compared to a 6.5-foot raise would allow for storage of additional water volume (and increased cold-water pool) behind the raised dam.

As described below, mean monthly flows at various modeling locations on the lower Sacramento River and tributaries under CP2 were compared with mean monthly flows simulated for the Existing Condition and No-Action Alternative conditions. See the Modeling Appendix for complete CalSim-II modeling results.

Lower Sacramento River As under CP1, monthly mean flows at the lower Sacramento River modeling locations under CP2 would be comparable to flows under the Existing Condition and No-Action Alternative conditions simulated for all months. Differences in monthly mean flow were generally small (less than 2 percent) and within the existing range of variability. Potential changes in flows would diminish rapidly downstream from RBPP because of increased effects from tributary inflows, diversions, and flood bypasses. Similarly, potential changes in water temperatures in the lower Sacramento River caused by small changes in releases would diminish rapidly downstream because of the increasing effects of inflows, atmospheric influences, and groundwater. Therefore, flow- and temperature-related impacts of CP2 on fish species in the lower Sacramento River would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Also, as under CP1, the effects of altered flow regimes resulting from implementation of CP2 are unlikely to extend into the lower Sacramento River downstream from Verona and into the Delta because the Central Valley's reservoirs and diversions are managed as a single integrated system (consisting of the SWP and the CVP). The operational requirements, including the 2008 USFWS BO and the 2009 NMFS BO, have been designed to maintain standards for flow to the lower Sacramento River and Delta. CVP and SWP operations must be consistent with these ESA BOs. Thus, implementation of CP2 would not likely alter flow to the Delta or water temperatures in the lower Sacramento River and its primary tributaries to a degree sufficient to affect Chinook salmon, steelhead, green sturgeon, Sacramento splittail, American shad, or striped bass relative to the Existing Condition and No-Action Alternative. Functional flows for fish migration, attraction, spawning, egg incubation, and rearing/emigration for all these fish species would be unchanged. Therefore, flow- and water temperature–related effects on these fish species would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Lower Feather River, American River, and Trinity River Also, as under CP1, monthly mean flows at modeling locations on the lower Feather River, the American River, and the Trinity River under CP2 would generally be equivalent to (less than 2-percent difference from) flows under the Existing Condition and No-Action Alternative simulated for most months. However, simulations for several months within the modeling record show substantial changes to flows in tributaries. Potential changes in flows could be reduced by real-time operations to meet existing rules and because of operation of upstream reservoirs (Lake Oroville, Folsom Lake, and Trinity Lake) and increasing effects from tributary inflows, diversions, and flood bypasses. Potential changes in water temperatures in the Feather River and American River caused by altered releases from reservoirs could diminish downstream because of the increasing effect of inflows, and atmospheric and groundwater influences. Nevertheless, based on predicted changes in flow and associated flow-habitat relationships, potential flow-related impacts on species of management concern in the American, Feather, and Trinity rivers could occur. This impact would be potentially significant. Mitigation for this impact is proposed in Section 11.3.4, "Mitigation Measures."

Impact Aqua-16 (CP2): Reduction in Ecologically Important Geomorphic Processes in the Lower Sacramento River Resulting from Reduced Frequency and Magnitude of Intermediate to High Flows Project operation could cause a reduction in intermediate to large flows both in the lower Sacramento River and in the lowermost (confluence) areas of tributaries. Such flows are necessary for channel forming and maintenance, meander migration, and the creation of seasonally inundated floodplains. These geomorphic processes are ecologically important because they are needed to maintain important aquatic habitat functions and values for fish and macroinvertebrate communities. This impact would be potentially significant.

This impact would be similar to Impact Aqua-16 (CP1). The impact could be greater under CP2 than under CP1 because the increased reservoir capacity associated with a 12.5-foot raise compared to a 6.5-foot raise would allow for storage of additional water volume (and flows) behind the raised dam.

Sediment transport, deposition, and scour regulate the formation of key habitat features such as point bars, gravel deposits, and SRA habitat. Intermediate to high flows and the associated stage elevation of the river surface also provide a backwater effect on the lowermost segment of tributaries, which reduces the potential for downcutting. These processes are regulated by the magnitude and frequency of flows. Relatively large floods provide the energy required to mobilize sediment from the riverbed, produce meander migration, increase stage elevation, create seasonally inundated floodplains, and inundate floodplain bypasses. Operations under CP2 could result in reduced intermediate to large flows that are necessary for channel forming and maintenance, meander migration, and the creation of seasonally inundated floodplains.

Implementation of CP2 would cause a further reduction in the magnitude, duration, and frequency of intermediate to large flows, relative to the Existing Condition and No-Action Alternative. Overall, the project would increase the existing, ongoing impacts on geomorphic processes resulting from operation of Shasta Dam that are necessary for channel forming and maintenance, meander migration, the creation of seasonally inundated floodplains, and the inundation of floodplain bypasses. These effects would likely occur along the upper reaches of the lower Sacramento River.

Reductions in the magnitude of high flows would likely be sufficient to reduce ecologically important processes along the upper Sacramento River and its floodplain bypasses. This impact would be potentially significant. Mitigation for this impact is proposed in Section 11.3.4, “Mitigation Measures.”

Impact Aqua-17 (CP2): Effects to Delta Fisheries Resulting from Changes to Delta Outflow Based on results of hydrologic modeling comparing Delta outflow under the No-Action Alternative, Existing Condition, and CP2, CP2 would result in changes to average monthly Delta outflow of less than 5 percent in all year types (with the exception of December of critical years under 2005 conditions). This impact on Delta fisheries and hydrologic transport processes within the Bay-Delta would be less than significant.

Results of the comparison of Delta outflows between CP2 and the Existing Condition and No-Action Alternative are summarized by month and water year type in Table 11-23. Delta outflow would increase by greater than 5 percent under CP2 only in December of critical water years. Based on the results of this analysis, CP2 would have a less-than-significant effect on Delta fisheries and hydrologic transport processes within the Bay-Delta. Mitigation for this impact is not needed, and thus not proposed.

Table 11-23. Delta Outflow Under the Existing Condition, No-Action Alternative, and CP2

		Existing Condition	CP2 (2005)		No-Action Alternative	CP2 (2030)	
Month	**Water Year**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**
January	Average	42,078	41,860	-1	42,169	41,892	-1
	W	84,136	83,807	0	84,037	83,397	-1
	AN	47,221	47,015	0	46,984	46,937	0
	BN	21,610	21,643	0	21,990	22,017	0
	D	14,166	13,955	-1	14,452	14,174	-2
	C	11,560	11,263	-3	11,757	11,682	-1

Table 11-23. Delta Outflow Under the Existing Condition, No-Action Alternative, and CP2 (contd.)

		Existing Condition	CP2 (2005)		No-Action Alternative	CP2 (2030)	
Month	**Water Year**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**
February	Average	51,618	51,459	0	51,430	51,194	0
	W	95,261	94,989	0	94,634	94,259	0
	AN	60,080	59,683	-1	60,278	59,494	-1
	BN	35,892	35,856	0	35,665	35,782	0
	D	20,978	20,902	0	20,946	20,812	-1
	C	12,902	12,954	0	13,088	13,142	0
March	Average	42,722	42,580	0	42,585	42,530	0
	W	78,448	78,493	0	78,376	78,446	0
	AN	53,486	52,768	-1	53,139	52,656	-1
	BN	23,102	22,799	-1	22,980	22,825	-1
	D	19,763	19,860	0	19,559	19,648	0
	C	11,881	11,740	-1	11,893	11,899	0
April	Average	30,227	30,239	0	30,743	30,782	0
	W	54,640	54,645	0	55,460	55,478	0
	AN	32,141	32,130	0	32,971	32,977	0
	BN	21,773	21,868	0	22,511	22,538	0
	D	14,347	14,317	0	14,538	14,621	1
	C	9,100	9,119	0	8,873	8,942	1
May	Average	22,619	22,539	0	22,249	22,170	0
	W	41,184	41,155	0	40,543	40,532	0
	AN	24,296	24,237	0	24,454	24,215	-1
	BN	16,346	15,984	-2	15,989	15,645	-2
	D	10,554	10,553	0	10,116	10,189	1
	C	6,132	6,134	0	5,910	5,927	0
June	Average	12,829	12,759	-1	12,660	12,595	-1
	W	23,473	23,471	0	23,015	23,027	0
	AN	12,080	11,650	-4	11,799	11,446	-3
	BN	7,995	7,992	0	7,991	7,939	-1
	D	6,691	6,666	0	6,764	6,727	-1
	C	5,361	5,361	0	5,378	5,376	0
July	Average	7,864	7,869	0	7,864	7,861	0
	W	11,230	11,243	0	11,181	11,177	0
	AN	9,562	9,538	0	9,407	9,386	0
	BN	7,117	7,124	0	7,225	7,259	0
	D	5,005	5,006	0	5,052	5,030	0
	C	4,034	4,053	0	4,098	4,097	0

Table 11-23. Delta Outflow Under the Existing Condition, No-Action Alternative, and CP2 (contd.)

		Existing Condition	CP2 (2005)		No-Action Alternative	CP2 (2030)	
Month	Water Year	Flow (cfs)	Flow (cfs)	Percent Change	Flow (cfs)	Flow (cfs)	Percent Change
August	Average	4,322	4,343	0	4,335	4,357	1
	W	5,302	5,313	0	5,097	5,091	0
	AN	4,000	4,000	0	4,000	4,000	0
	BN	4,000	4,000	0	4,002	4,000	0
	D	3,906	3,895	0	4,142	4,198	1
	C	3,520	3,655	4	3,699	3,782	2
September	Average	9,841	9,845	0	9,844	9,882	0
	W	19,695	19,670	0	19,702	19,713	0
	AN	11,784	11,771	0	11,849	11,836	0
	BN	3,876	3,878	0	3,913	3,932	0
	D	3,508	3,554	1	3,442	3,591	4
	C	3,008	3,033	1	3,005	3,008	0
October	Average	6,067	6,081	0	6,000	6,000	0
	W	7,926	7,872	-1	7,633	7,550	-1
	AN	5,309	5,334	0	5,476	5,546	1
	BN	5,479	5,551	1	5,502	5,510	0
	D	5,228	5,250	0	5,236	5,243	0
	C	4,741	4,815	2	4,714	4,804	2
November	Average	11,706	11,549	-1	11,675	11,500	-1
	W	17,717	17,588	-1	17,715	17,488	-1
	AN	12,667	11,996	-5	12,491	11,965	-4
	BN	8,543	8,501	0	8,686	8,586	-1
	D	8,482	8,483	0	8,414	8,375	0
	C	6,250	6,173	-1	6,150	6,150	0
December	Average	21,755	21,621	-1	21,745	21,471	-1
	W	44,974	44,605	-1	44,661	43,902	-2
	AN	18,581	18,426	-1	18,562	18,375	-1
	BN	12,219	12,041	-1	12,326	12,246	-1
	D	8,531	8,494	0	8,803	8,678	-1
	C	5,580	5,882	5	5,677	5,920	4

Note: A negative percentage change reflects a reduction in Delta outflow
Key:
AN = above-normal
BN = below-normal
C = critical
cfs = cubic feet per second
CP = Comprehensive Plan
D = dry
W = wet

Impact Aqua-18 (CP2): Effects to Delta Fisheries Resulting from Changes to Delta Inflow Based on the results of hydrologic modeling comparing Delta inflow under CP2 to the Existing Condition and No-Action Alternative, CP2 would not decrease average monthly Delta inflow by 5 percent or more in any year type. This impact on Delta fisheries and hydrologic transport processes within the Bay-Delta would be less than significant.

Results of the comparison of Delta inflows between the No-Action Alternative, Existing Condition, and CP2 are summarized by month and water year type in Table 11-24. Under CP2, Delta inflow would not decrease by more than 5 percent during any month compared to either the Existing Condition or the No-Action Alternative. Based on the results of this comparison, CP2 would have a less-than-significant effect on Delta fisheries and hydrologic transport processes within the Bay-Delta as a consequence of changes in Delta inflow. Mitigation for this impact is not needed, and thus not proposed.

Table 11-24. Delta Inflow Under the Existing Condition, No-Action Alternative, and CP2

		Existing Condition	CP2 (2005)		No-Action Alternative	CP2 (2030)	
Month	Water Year	Flow (cfs)	Flow (cfs)	Percent Change	Flow (cfs)	Flow (cfs)	Percent Change
January	Average	47,426	47,218	0	47,457	47,194	-1
	W	89,431	89,103	0	89,328	88,690	-1
	AN	51,611	51,349	-1	51,267	51,113	0
	BN	27,269	27,305	0	27,576	27,603	0
	D	20,125	19,959	-1	20,371	20,094	-1
	C	16,699	16,457	-1	16,749	16,872	1
February	Average	57,835	57,676	0	57,623	57,385	0
	W	103,140	102,862	0	102,606	102,252	0
	AN	65,379	64,734	-1	65,574	64,768	-1
	BN	41,782	41,822	0	41,374	41,385	0
	D	26,530	26,473	0	26,431	26,332	0
	C	17,818	18,017	1	17,958	18,035	0
March	Average	49,829	49,721	0	49,713	49,647	0
	W	87,688	87,726	0	87,703	87,793	0
	AN	61,498	61,010	-1	61,339	60,883	-1
	BN	30,569	30,281	-1	30,415	30,256	-1
	D	24,943	24,955	0	24,640	24,639	0
	C	15,933	15,916	0	15,896	15,895	0
April	Average	33,962	33,976	0	34,783	34,823	0
	W	58,684	58,688	0	60,017	60,025	0
	AN	35,588	35,578	0	36,738	36,745	0
	BN	25,351	25,447	0	26,403	26,429	0
	D	17,962	17,939	0	18,315	18,411	1
	C	12,817	12,837	0	12,635	12,707	1

Table 11-24. Delta Inflow Under the Existing Condition, No-Action Alternative, and CP2 (contd.)

		Existing Condition	CP2 (2005)		No-Action Alternative	CP2 (2030)	
Month	Water Year	Flow (cfs)	Flow (cfs)	Percent Change	Flow (cfs)	Flow (cfs)	Percent Change
May	Average	27,383	27,305	0	27,091	27,021	0
	W	46,973	46,945	0	46,494	46,482	0
	AN	28,466	28,407	0	28,711	28,475	-1
	BN	20,747	20,382	-2	20,427	20,083	-2
	D	14,882	14,881	0	14,534	14,609	1
	C	10,347	10,360	0	10,038	10,110	1
June	Average	22,171	22,118	0	22,090	22,042	0
	W	35,459	35,457	0	35,172	35,190	0
	AN	23,124	22,687	-2	22,776	22,423	-2
	BN	16,884	16,985	1	16,941	17,008	0
	D	14,095	14,067	0	14,337	14,278	0
	C	10,710	10,713	0	10,694	10,695	0
July	Average	23,099	23,131	0	22,839	22,906	0
	W	27,442	27,453	0	27,496	27,491	0
	AN	25,169	25,083	0	25,065	25,033	0
	BN	23,282	23,292	0	23,362	23,288	0
	D	20,937	20,930	0	20,082	20,300	1
	C	14,647	14,929	2	14,048	14,311	2
August	Average	17,147	17,158	0	17,026	17,094	0
	W	20,235	20,253	0	20,154	20,148	0
	AN	18,784	18,762	0	18,927	18,941	0
	BN	18,274	18,171	-1	18,297	18,232	0
	D	15,066	15,288	1	14,371	14,688	2
	C	10,626	10,472	-1	10,850	10,913	1
September	Average	20,946	21,074	1	21,145	21,396	1
	W	31,918	31,921	0	32,428	32,422	0
	AN	23,912	23,931	0	24,747	24,859	0
	BN	16,518	16,518	0	16,563	16,592	0
	D	14,440	14,839	3	14,233	15,081	6
	C	9,130	9,383	3	8,809	9,118	4
October	Average	14,407	14,455	0	14,175	14,260	1
	W	17,072	16,986	-1	16,558	16,547	0
	AN	13,176	13,416	2	13,223	13,412	1
	BN	14,044	14,203	1	14,159	14,175	0
	D	13,133	13,270	1	12,846	13,115	2
	C	12,196	12,079	-1	11,976	11,968	0

Table 11-24. Delta Inflow Under the Existing Condition, No-Action Alternative, and CP2 (contd.)

		Existing Condition	CP2 (2005)		No-Action Alternative	CP2 (2030)	
Month	**Water Year**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**
November	Average	19,512	19,583	0	19,463	19,510	0
	W	26,429	26,528	0	26,536	26,428	0
	AN	20,269	19,859	-2	20,052	19,788	-2
	BN	16,984	17,053	0	16,980	16,986	0
	D	15,771	16,039	2	15,705	16,074	2
	C	12,330	12,530	2	12,081	12,339	0
December	Average	30,984	30,850	0	30,988	30,692	-1
	W	53,758	53,401	-1	53,516	52,765	-1
	AN	28,431	28,303	0	28,223	28,079	-1
	BN	21,958	21,784	-1	22,143	22,046	0
	D	18,560	18,520	0	18,837	18,696	-1
	C	13,363	13,607	2	13,484	13,560	1

Note: A negative percentage change reflects a reduction in Delta inflow
Key:
AN = above-normal
BN = below-normal
C = critical
cfs = cubic feet per second
CP = Comprehensive Plan
D = dry
W = wet

Impact Aqua-19 (CP2): Effects to Delta Fisheries Resulting from Changes in Sacramento River Inflow CP2 operation would result in a variable response in Sacramento River inflow, resulting in both increases and decreases in river flow above basis-of-comparison conditions depending on month and water year type. Decreases in Sacramento River inflow would not equal or exceed 5 percent. This impact would be less than significant.

Results of hydrologic modeling, by month and water year type, for the Existing Condition, No-Action Alternative, and CP2 for Sacramento River inflow are presented in Table 11-25. Results of these analyses show a variable response in Sacramento River inflow with CP2 operations resulting in both increases and decreases in river inflow above the Existing Condition and the No-Action Alternative, depending on month and water year type. Under CP2, Sacramento River inflow would not decrease by 5 percent or more. Based on these results the impact of CP2 on fish habitat and transport mechanisms within the lower Sacramento River and Delta would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 11-25. Sacramento River Inflow Under the Existing Condition, No-Action Alternative, and CP2

		Existing Condition	CP2 (2005)		No-Action Alternative	CP2 (2030)	
Month	**Water Year**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**
January	Average	31,139	31,061	0	31,167	31,107	0
	W	50,173	50,083	0	50,164	49,991	0
	AN	38,122	38,034	0	38,006	37,988	0
	BN	22,370	22,485	1	22,540	22,649	0
	D	16,980	16,886	-1	17,109	16,929	-1
	C	14,384	14,145	-2	14,322	14,442	1
February	Average	36,608	36,596	0	36,618	36,563	0
	W	56,740	56,796	0	56,637	56,659	0
	AN	44,453	44,029	-1	44,672	44,176	-1
	BN	30,911	31,054	0	30,780	30,923	0
	D	21,249	21,192	0	21,237	21,120	-1
	C	14,830	15,028	1	15,075	15,152	1
March	Average	32,396	32,332	0	32,352	32,319	0
	W	49,248	49,293	0	49,403	49,461	0
	AN	44,060	43,860	0	43,972	43,783	0
	BN	23,188	22,900	-1	23,068	22,928	-1
	D	20,390	20,400	0	20,138	20,135	0
	C	12,971	12,954	0	12,942	12,941	0
April	Average	23,232	23,246	0	23,206	23,247	0
	W	37,918	37,923	0	38,019	38,030	0
	AN	26,053	26,044	0	26,039	26,049	0
	BN	17,518	17,613	1	17,439	17,465	0
	D	13,205	13,182	0	13,164	13,261	1
	C	10,295	10,314	0	10,067	10,140	1
May	Average	19,417	19,341	0	19,114	19,046	0
	W	32,095	32,075	0	31,800	31,795	0
	AN	21,204	21,145	0	21,080	20,843	-1
	BN	14,530	14,166	-3	14,144	13,801	-2
	D	11,226	11,225	0	10,836	10,911	1
	C	8,148	8,161	0	7,874	7,946	1
June	Average	16,508	16,455	0	16,511	16,462	0
	W	24,092	24,089	0	23,905	23,920	0
	AN	16,598	16,160	-3	16,533	16,179	-2
	BN	13,792	13,894	1	13,822	13,889	0
	D	12,283	12,256	0	12,569	12,509	0
	C	9,492	9,494	0	9,516	9,517	0
July	Average	19,518	19,551	0	19,266	19,333	0
	W	20,071	20,081	0	20,058	20,052	0
	AN	22,070	21,983	0	21,976	21,942	0
	BN	21,232	21,242	0	21,374	21,301	0
	D	19,577	19,571	0	18,788	19,006	1
	C	13,683	13,964	2	13,100	13,363	2
August	Average	14,710	14,721	0	14,596	14,663	0
	W	16,285	16,303	0	16,189	16,182	0
	AN	16,418	16,396	0	16,561	16,574	0
	BN	16,112	16,010	-1	16,170	16,106	0
	D	13,632	13,855	2	12,968	13,284	2
	C	9,570	9,416	-2	9,785	9,847	1

Table 11-25. Sacramento River Inflow Under the Existing Condition, No-Action Alternative, and CP2 (contd.)

		Existing Condition	CP2 (2005)		No-Action Alternative	CP2 (2030)	
Month	**Water Year**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**
September	Average	18,211	18,338	1	18,417	18,667	1
	W	27,839	27,841	0	28,337	28,331	0
	AN	21,244	21,262	0	22,088	22,200	1
	BN	14,088	14,088	0	14,147	14,175	0
	D	12,522	12,915	3	12,341	13,189	7
	C	7,664	7,917	3	7,347	7,655	4
October	Average	11,309	11,401	1	11,117	11,210	1
	W	13,419	13,472	0	13,040	13,056	0
	AN	10,499	10,738	2	10,571	10,760	2
	BN	11,053	11,211	1	11,195	11,211	0
	D	10,150	10,287	1	9,830	10,100	3
	C	9,587	9,471	-1	9,333	9,325	0
November	Average	15,640	15,735	1	15,605	15,699	1
	W	20,726	20,893	1	20,832	20,854	0
	AN	16,893	16,497	-2	16,666	16,449	-1
	BN	13,755	13,823	0	13,793	13,798	0
	D	12,720	12,988	2	12,723	13,091	3
	C	9,948	10,149	2	9,653	9,911	3
December	Average	23,248	23,227	0	23,229	23,124	0
	W	37,645	37,487	0	37,434	37,188	-1
	AN	22,604	22,586	0	22,461	22,378	0
	BN	16,930	16,956	0	17,103	17,134	0
	D	15,760	15,720	0	15,934	15,793	-1
	C	11,303	11,547	2	11,310	11,386	1

Note: A negative percentage change reflects a reduction in Sacramento River inflow
Key:
AN = above-normal
BN = below-normal
C = critical
cfs = cubic feet per second
CP = Comprehensive Plan
D = dry
W = wet

Impact Aqua-20 (CP2): Effects to Delta Fisheries Resulting from Changes in San Joaquin River Flow at Vernalis CP2 operation would result in no discernible change in San Joaquin River flows at Vernalis, and therefore no impact to Delta fisheries or transport mechanisms within the lower San Joaquin River and Delta would occur under CP2 relative to the No-Action Alternative or Existing Condition. There would be no impact.

Results of hydrologic modeling, by month and water year type, for the Existing Condition, No-Action Alternative, and CP2 for San Joaquin River flow are summarized in Table 11-26. Results of these analyses show that the proposed CP2 would have no effect on seasonal San Joaquin River flows compared with the Existing Condition and No-Action Alternative. Based on these results CP2 would have no impact on Delta fisheries or transport mechanisms within the lower San Joaquin River and Delta. Mitigation for this impact is not needed, and thus not proposed.

Table 11-26. San Joaquin River Flow at Vernalis Under the Existing Condition and CP2

		Existing Condition	CP2 (2005)		No-Action Alternative	CP2 (2030)	
Month	**Water Year**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**
January	Average	4,770	4,770	0	4,764	4,764	0
	W	9,273	9,273	0	9,097	9,097	0
	AN	4,223	4,223	0	4,259	4,259	0
	BN	2,986	2,986	0	3,081	3,081	0
	D	2,084	2,084	0	2,160	2,160	0
	C	1,673	1,673	0	1,746	1,746	0
February	Average	6,265	6,265	0	6,143	6,143	0
	W	11,036	11,036	0	10,845	10,845	0
	AN	6,047	6,047	0	6,179	6,179	0
	BN	5,767	5,767	0	5,565	5,565	0
	D	2,642	2,642	0	2,528	2,528	0
	C	2,161	2,161	0	2,014	2,014	0
March	Average	7,133	7,133	0	7,003	7,003	0
	W	13,443	13,443	0	13,170	13,170	0
	AN	6,788	6,788	0	6,674	6,673	0
	BN	5,322	5,322	0	5,293	5,293	0
	D	2,963	2,963	0	2,895	2,895	0
	C	2,176	2,176	0	2,129	2,129	0
April	Average	6,720	6,720	0	7,533	7,533	0
	W	11,420	11,420	0	12,614	12,614	0
	AN	6,671	6,671	0	7,799	7,798	0
	BN	5,852	5,852	0	6,910	6,910	0
	D	3,726	3,726	0	4,112	4,112	0
	C	2,087	2,087	0	2,118	2,118	0
May	Average	6,204	6,204	0	6,234	6,234	0
	W	11,268	11,268	0	11,135	11,135	0
	AN	5,611	5,611	0	5,987	5,987	0
	BN	5,010	5,010	0	5,108	5,108	0
	D	3,070	3,070	0	3,111	3,111	0
	C	1,920	1,920	0	1,862	1,862	0
June	Average	4,739	4,739	0	4,671	4,671	0
	W	9,451	9,451	0	9,390	9,390	0
	AN	5,608	5,609	0	5,326	5,326	0
	BN	2,424	2,424	0	2,471	2,470	0
	D	1,598	1,598	0	1,554	1,554	0
	C	1,076	1,076	0	1,035	1,035	0

Table 11-26. San Joaquin River Flow at Vernalis Under the Existing Condition and CP2 (contd.)

		Existing Condition	CP2 (2005)		No-Action Alternative	CP2 (2030)	
Month	Water Year	Flow (cfs)	Flow (cfs)	Percent Change	Flow (cfs)	Flow (cfs)	Percent Change
July	Average	3,202	3,202	0	3,208	3,208	0
	W	6,556	6,556	0	6,660	6,660	0
	AN	2,783	2,784	0	2,767	2,768	0
	BN	1,775	1,775	0	1,733	1,733	0
	D	1,282	1,282	0	1,216	1,216	0
	C	898	898	0	880	880	0
August	Average	2,029	2,029	0	2,040	2,041	0
	W	3,099	3,099	0	3,158	3,159	0
	AN	2,020	2,020	0	2,014	2,015	0
	BN	1,828	1,828	0	1,817	1,816	0
	D	1,342	1,342	0	1,315	1,315	0
	C	984	984	0	993	993	0
September	Average	2,331	2,331	0	2,340	2,340	0
	W	3,274	3,274	0	3,317	3,317	0
	AN	2,328	2,328	0	2,312	2,312	0
	BN	2,109	2,109	0	2,119	2,119	0
	D	1,795	1,795	0	1,774	1,775	0
	C	1,358	1,358	0	1,355	1,355	0
October	Average	2,757	2,757	0	2,753	2,753	0
	W	3,112	3,112	0	3,107	3,107	0
	AN	2,446	2,446	0	2,424	2,424	0
	BN	2,749	2,749	0	2,718	2,718	0
	D	2,686	2,686	0	2,710	2,710	0
	C	2,416	2,416	0	2,423	2,423	0
November	Average	2,633	2,633	0	2,603	2,603	0
	W	3,372	3,372	0	3,340	3,340	0
	AN	2,213	2,213	0	2,176	2,176	0
	BN	2,412	2,412	0	2,360	2,360	0
	D	2,388	2,388	0	2,355	2,355	0
	C	2,075	2,075	0	2,088	2,088	0

Table 11-26. San Joaquin River Flow at Vernalis Under the Existing Condition and CP2 (contd.)

		Existing Condition	CP2 (2005)		No-Action Alternative	CP2 (2030)	
Month	**Water Year**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**
December	Average	3,199	3,199	0	3,263	3,263	0
	W	5,081	5,081	0	5,178	5,178	0
	AN	2,916	2,916	0	2,899	2,899	0
	BN	2,705	2,705	0	2,753	2,753	0
	D	2,047	2,047	0	2,123	2,123	0
	C	1,710	1,710	0	1,785	1,785	0

Note:
A negative percentage change reflects a reduction in San Joaquin River flow.

Key:
AN = above-normal
BN = below-normal
C = critical
cfs = cubic feet per second
CP = Comprehensive Plan
D = dry
W = wet

Impact Aqua-21 (CP2): Reduction in Low-Salinity Habitat Conditions Resulting from an Upstream Shift in X2 Location CP2 operation would result in less than 0.5 km movement upstream or downstream from the X2 location from its location during February through May or September through November under the Existing Condition or No-Action Alternative, and thus cause minimal reduction in low-salinity habitats. This impact would be less than significant.

Results of the comparison of X2 position under the Existing Condition, No-Action Alternative, and CP2 are summarized in Table 11-27. The results showed that changes in X2 location under CP2 as compared with the Existing Condition during February through May and September through November would be less than 1 km (all were less than 0.3 km) with both variable upstream and downstream movement of the X2 location, depending on month and water year type. Changes in X2 location between the No-Action Alternative and CP2 assuming future operating conditions would also be small (less than 0.4 km). These results are consistent with model results for Delta outflow that showed a less-than-significant change in flows. Based on these results, CP2 would have a less-than-significant impact on low-salinity habitat conditions within the Bay-Delta. Mitigation for this impact is not needed, and thus not proposed.

Table 11-27. X2 Under the Existing Condition, No-Action Alternative, and CP2

		Existing Condition	CP2 (2005)		No-Action Alternative	CP2 (2030)	
Month	Water Year	Location (km)	Location (km)	Difference (km)	Location (km)	Location (km)	Difference (km)
January	Average	67.5	67.5	0.0	67.3	67.3	0.0
	W	53.6	53.7	0.0	53.7	53.7	0.1
	AN	61.7	61.7	0.0	61.6	61.5	0.0
	BN	72.1	72.0	-0.1	71.7	71.6	-0.1
	D	77.9	78.0	0.1	77.4	77.6	0.2
	C	82.2	82.2	0.0	81.9	81.8	-0.1
February	Average	60.9	60.9	0.0	60.8	60.9	0.0
	W	50.4	50.4	0.0	50.4	50.4	0.0
	AN	54.8	54.8	0.0	54.6	54.6	0.1
	BN	61.0	60.9	0.0	60.9	60.9	0.0
	D	70.1	70.1	0.0	69.9	70.0	0.0
	C	76.2	76.2	0.0	75.9	76.1	0.2
March	Average	60.9	60.9	0.0	60.9	60.9	0.0
	W	52.1	52.1	0.0	52.1	52.1	0.0
	AN	53.6	53.7	0.0	53.7	53.7	0.0
	BN	63.3	63.4	0.1	63.3	63.4	0.0
	D	67.1	67.0	-0.1	67.2	67.1	0.0
	C	75.2	75.3	0.1	75.1	75.1	0.1
April	Average	63.5	63.5	0.0	63.4	63.4	0.0
	W	54.5	54.5	0.0	54.3	54.3	0.0
	AN	58.6	58.6	0.0	58.4	58.4	0.0
	BN	64.5	64.5	0.0	64.1	64.1	0.0
	D	69.9	69.9	0.0	69.9	69.8	-0.1
	C	77.5	77.5	0.0	77.6	77.6	0.0
May	Average	67.5	67.5	0.0	67.7	67.7	0.0
	W	57.6	57.6	0.0	57.7	57.7	0.0
	AN	62.7	62.7	0.0	62.6	62.6	0.1
	BN	68.3	68.4	0.1	68.3	68.4	0.1
	D	74.4	74.4	0.0	74.8	74.7	-0.1
	C	82.5	82.5	0.0	82.9	82.8	-0.1
June	Average	74.5	74.6	0.0	74.7	74.7	0.0
	W	65.0	65.0	0.0	65.2	65.2	0.0
	AN	72.6	72.8	0.2	72.7	72.8	0.1
	BN	76.6	76.6	0.0	76.7	76.8	0.1
	D	80.4	80.5	0.0	80.7	80.7	0.0
	C	85.9	85.9	0.0	86.0	86.0	0.0

Table 11-27. X2 Under the Existing Condition, No-Action Alternative, and CP2 (contd.)

		Existing Condition	CP2 (2005)		No-Action Alternative	CP2 (2030)	
Month	**Water Year**	**Location (km)**	**Location (km)**	**Difference (km)**	**Location (km)**	**Location (km)**	**Difference (km)**
July	Average	80.5	80.5	0.0	80.5	80.5	0.0
	W	74.4	74.4	0.0	74.5	74.5	0.0
	AN	78.1	78.2	0.1	78.4	78.4	0.1
	BN	81.7	81.7	0.0	81.6	81.6	0.0
	D	84.8	84.9	0.0	84.8	84.8	0.0
	C	88.1	88.1	0.0	88.0	88.0	0.0
August	Average	85.6	85.6	0.0	85.6	85.5	0.0
	W	82.7	82.6	0.0	82.8	82.8	0.0
	AN	83.7	83.8	0.0	83.9	83.9	0.0
	BN	85.6	85.6	0.0	85.5	85.4	0.0
	D	87.8	87.8	0.0	87.5	87.5	0.0
	C	90.4	90.3	-0.1	90.2	90.2	0.0
September	Average	83.7	83.7	0.0	83.7	83.6	0.0
	W	73.4	73.4	0.0	73.5	73.5	0.0
	AN	81.4	81.4	0.0	81.4	81.4	0.0
	BN	88.8	88.8	0.0	88.8	88.8	0.0
	D	90.2	90.2	0.0	90.0	89.9	-0.1
	C	92.5	92.4	-0.1	92.3	92.3	0.0
October	Average	83.9	83.9	0.0	83.9	83.9	0.0
	W	73.6	73.6	0.0	73.7	73.7	0.0
	AN	79.8	79.8	0.0	79.8	79.8	0.0
	BN	88.9	88.9	0.0	88.9	88.9	0.0
	D	91.4	91.4	0.0	91.3	91.2	-0.1
	C	93.3	93.2	-0.1	93.1	93.0	-0.1
November	Average	82.2	82.3	0.1	82.2	82.3	0.1
	W	73.1	73.1	0.0	73.2	73.2	0.0
	AN	78.4	78.4	0.0	78.4	78.5	0.1
	BN	84.8	85.3	0.5	84.8	85.2	0.4
	D	88.9	89.0	0.0	88.8	88.9	0.1
	C	92.6	92.7	0.0	92.8	92.6	-0.1
December	Average	76.1	76.2	0.1	76.0	76.0	0.0
	W	62.9	63.0	0.1	63.0	63.1	0.1
	AN	76.4	76.7	0.3	76.4	76.6	0.2
	BN	81.4	81.3	0.0	81.1	81.1	0.0
	D	82.8	82.9	0.1	82.6	82.7	0.1
	C	87.9	87.9	0.0	87.8	87.7	-0.1

Key:
AN = above-normal
BN = below-normal
C = critical
CP = Comprehensive Plan
D = dry
km = kilometer
W = wet

Impact Aqua-22 (CP2): Increase in Mortality of Species of Primary Management Concern as a Result of Increased Reverse Flows in the Old and Middle Rivers CP2 operation would result in minimal changes to reverse flows in Old and Middle rivers. The increases in reverse flows under CP2 would not be expected to contribute to an increase in the vulnerability of Chinook salmon, delta smelt, longfin smelt striped bass, threadfin shad, and other resident warm-water fish to increased salvage and potential losses because the flows do not exceed (become more negative) -5,000 cfs. This impact would be less than significant.

Results of the analysis showed two occurrences relative to the Existing Condition when reverse flows within Old and Middle rivers would increase by more than 5 percent. Based on results of the delta smelt analysis of the relationship between reverse flows and delta smelt salvage in March, the increased reverse flows from approximately -4,000 cfs to -4,200 cfs in above-normal water years, and around -2,000 to -2,100 in critical water years would not be expected to result in a significant increase in adverse effects to delta smelt (Table 11-28). Additionally, given the tidal volumes and hydrodynamics of the Old and Middle river region, it is not expected that the change in reverse flows in March would result in detectable changes in fish survival, including for Chinook salmon, striped bass, and other anadromous and resident warm-water fishes.

Table 11-28. Old and Middle River Reverse Flows for the Existing Condition, No-Action Alternative, and CP2

		Existing Condition	CP2 (2005)		No-Action Alternative	CP2 (2030)	
Month	**Water Year**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**
January	Average	-3,542	-3,550	0	-3,553	-3,566	0
	W	-2,034	-2,034	0	-2,151	-2,151	0
	AN	-3,654	-3,598	-2	-3,574	-3,479	-3
	BN	-4,240	-4,240	0	-4,240	-4,240	0
	D	-4,773	-4,813	1	-4,772	-4,771	0
	C	-4,033	-4,086	1	-3,940	-4,122	5
February	Average	-3,293	-3,289	0	-3,358	-3,351	0
	W	-2,745	-2,735	0	-2,950	-2,970	1
	AN	-3,248	-3,011	-7	-3,165	-3,142	-1
	BN	-3,335	-3,401	2	-3,291	-3,195	-3
	D	-4,016	-4,028	0	-4,045	-4,065	0
	C	-3,391	-3,527	4	-3,482	-3,497	0

Table 11-28. Old and Middle River Reverse Flows for the Existing Condition, No-Action Alternative, and CP2 (contd.)

		Existing Condition	CP2 (2005)		No-Action Alternative	CP2 (2030)	
Month	**Water Year**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**
March	Average	-2,784	-2,814	1	-2,877	-2,867	0
	W	-1,792	-1,786	0	-2,023	-2,044	1
	AN	-4,021	-4,230	5	-4,260	-4,282	1
	BN	-4,005	-4,015	0	-3,982	-3,979	0
	D	-2,951	-2,873	-3	-2,918	-2,834	-3
	C	-2,023	-2,136	6	-1,994	-1,985	0
April	Average	955	954	0	1,060	1,061	0
	W	2,706	2,706	0	2,798	2,806	0
	AN	1,087	1,087	0	1,314	1,314	0
	BN	697	697	0	898	898	0
	D	-244	-247	1	-207	-214	4
	C	-874	-874	0	-872	-872	0
May	Average	491	490	0	416	409	-2
	W	2,077	2,077	0	1,781	1,781	0
	AN	562	562	0	646	646	0
	BN	277	277	0	270	270	0
	D	-674	-674	0	-696	-696	0
	C	-1,018	-1,028	1	-936	-984	5
June	Average	-3,654	-3,669	0	-3,718	-3,734	0
	W	-4,226	-4,226	0	-4,354	-4,360	0
	AN	-4,825	-4,819	0	-4,818	-4,818	0
	BN	-4,137	-4,233	2	-4,119	-4,227	3
	D	-3,079	-3,079	0	-3,205	-3,184	-1
	C	-1,542	-1,542	0	-1,542	-1,542	0
July	Average	-9,502	-9,526	0	-9,292	-9,361	1
	W	-8,948	-8,946	0	-8,905	-8,903	0
	AN	-9,993	-9,935	-1	-9,929	-9,918	0
	BN	-10,886	-10,888	0	-10,903	-10,826	-1
	D	-10,998	-10,992	0	-10,419	-10,638	2
	C	-6,355	-6,588	4	-5,928	-6,168	4

Note:
A positive percentage change reflects more negative reverse flows under CP2 when compared to the Existing Condition or the No-Action Alternative.
Key:
AN = above-normal
BN = below-normal
C = critical
cfs = cubic feet per second
CP = Comprehensive Plan
D = dry
W = wet

Juvenile Chinook salmon and steelhead migrate through the Delta during January, and an increase in average monthly reverse flows of 100 to 200 cfs would be expected to increase the potential risk of increased mortality to these species. However, given the tidal volumes and hydrodynamics of the Old and Middle river region, it is not expected that the change in reverse flows in January in a critical year would result in a detectable change in fish survival. The majority of juvenile Chinook salmon emigrating from the San Joaquin River typically migrate downstream later in dry years and would not be expected to occur in high numbers within Old and Middle rivers in January. Delta smelt would not be significantly affected by the slight increase in reverse flows in January because their presence in the region is minimal during this time. Longfin smelt larvae, however, are present in January, particularly in critical years, however, reverse flows do not exceed (become more negative) -5,000 cfs, and therefore, do not constitute a significant impact to longfin smelt.

Under 2030 conditions, the increase in reverse flows estimated to occur under CP2 in critical water years in May would be 5 percent, but the flows are less than 1,000 cfs. The increased reverse flows in May of critical water years occurred at a time of the year when water temperatures in the Delta were elevated and juvenile Chinook salmon or steelhead could occur in the area in high numbers. However, changes to reverse flows in March and May would not exceed the -5,000 cfs criteria established by the USFWS and NMFS BOs, and would result in less-than-significant impacts to Chinook salmon and steelhead.

Juvenile delta smelt may occur in the area in May; however a change in Old and Middle rivers flow of approximately 100 to 200 cfs may result in a small increase in their vulnerability to CVP and SWP salvage, but this increase is expected to be less than significant. As water temperatures increase in the Delta during May, the majority of delta smelt move towards Suisun Bay where temperatures are more suitable. The increase in reverse flows in May of a critical year would be expected to contribute to a small increase in the vulnerability of juvenile striped bass, threadfin shad, and other resident warm-water fish to increased salvage and potential losses as a result of increased reverse flows. The increased reverse flows in low-flow years would be expected to result in a low, but potentially significant, increase in mortality for resident warm-water fish inhabiting the south Delta under CP2.

The potential increase in losses relative to the Existing Conditions during March and No-Action Alternative during January and May is considered to be less than significant. Mitigation for this impact is not proposed because operations will be guided by RPAs established by NMFS and USFWS BOs to reduce any impacts to listed fish species.

Impact Aqua-23 (CP2): Increase in the Risk of Entrainment or Salvage of Species of Primary Management Concern at CVP and SWP Export Facilities Due to Changes in CVP and SWP Exports CP2 operations may result in an increase in CVP and SWP exports, which is assumed to result in a direct proportional increase in the risk of fish being entrained and salvaged at the facilities. Future operations of the SWP and CVP export facilities would continue to be managed and regulated in accordance with incidental take limits established for each of the protected fish by USFWS, NMFS, and CDFW. The resulting impact to Chinook salmon, steelhead, and longfin smelt would be less than significant; the resulting impact to delta smelt, striped bass, and splittail would be potentially significant. Overall, this impact would be potentially significant.

Results of entrainment loss modeling at the CVP and SWP export facilities are presented in Table 11-29 for CP2. The estimated index of total numbers of fish lost annually, by species, are presented in Attachment 1 of the *Fisheries and Aquatic Ecosystems Technical Report.* The difference between fish losses under CP2 relative to the No-Action Alternative and the Existing Condition is represented as the entrainment index, shown in Table 11-29, to represent the effect of project operations on each fish species at the CVP and SWP facilities.

Table 11-29. Indices of Entrainment at the CVP and SWP Facilities Under the Existing Condition, No-Action Alternative, and CP2

Species	Water Year	CP2 Minus Existing Condition	Percent Change	CP2 Minus No-Action Alternative	Percent Change
Delta Smelt	Average	68	0.2	138	0.3
	W	-7	-0.0	21	0.0
	AN	-58	-0.1	-28	-0.1
	BN	273	0.8	255	0.7
	D	0	0.0	-19	-0.1
	C	219	0.9	656	2.9
Salmon	Average	77	0.1	83	0.2
	W	-20	-0.0	34	0.0
	AN	-118	-0.2	-84	-0.2
	BN	223	0.5	6	0.0
	D	-24	-0.1	-62	-0.1
	C	464	1.3	665	2.0
Longfin Smelt	Average	5	0.1	22	0.3
	W	-1	-0.0	-4	-0.0
	AN	1	0.0	0	-0.0
	BN	3	0.1	3	0.1
	D	1	0.0	2	0.0
	C	32	0.6	149	2.9
Steelhead	Average	7	0.2	-1	-0.0
	W	-3	-0.1	9	0.2
	AN	-30	-0.7	-17	-0.4
	BN	21	0.5	-25	-0.6
	D	-4	-0.1	-9	-0.3
	C	68	2.4	35	1.3
Striped Bass	Average	5,229	0.4	8,231	0.6
	W	1,762	0.1	2,140	0.1
	AN	-322	-0.0	2,527	0.2
	BN	10,781	0.8	7,230	0.5
	D	5,807	0.5	17,295	1.6
	C	10,946	1.8	14,704	2.5
Splittail	Average	766	0.3	1,247	0.5
	W	-33	-0.0	187	0.0
	AN	-737	-0.2	-88	-0.0
	BN	3,196	1.2	2,823	1.1
	D	13	0.0	1,479	0.7
	C	2,294	2.2	2,694	2.8

Note:
Negative percentage change reflects a reduction in entrainment risk while a positive percentage change reflects an increase in entrainment risk.
Key:
AN = above-normal
BN = below-normal
C = critical
CP = Comprehensive Plan
D = dry
W = wet

Results of the entrainment risk calculations for delta smelt showed a change of less than 1 percent from the Existing Condition in all water years (Table 11-29). The greatest increase in risk (0.9 percent) was estimated for CP2 in a critical year. The entrainment risk for delta smelt relative to the No-Action Alternative would increase in critical years by almost 3 percent (Table 11-29). Although the incremental change in the risk of delta smelt losses resulting from CVP and SWP export operations would be small, the delta smelt population abundance is currently at such critically low levels that even a small increase in the risk of losses is considered to be potentially significant. The increase in risk would also contribute to cumulative factors affecting the survival of delta smelt.

The estimated change in the risk of losses for Chinook salmon under CP2 follows a similar pattern to that described for delta smelt (Table 11-29). Overall, CP2 would result in a small increase in the risk of losses relative to both the Existing Condition and No-Action Alternative. The change in risk under CP2 would not exceed 2 percent in any year type as compared with the Existing Condition and the No-Action Alternative, and is considered to be less than significant. Given the numbers of juvenile Sacramento and San Joaquin river Chinook salmon produced each year in the Central Valley, the relatively small incremental increase in the risk of entrainment/salvage at the CVP and SWP export facilities is considered to be a less-than-significant direct impact but would contribute incrementally to the overall cumulative factors affecting juvenile Chinook salmon survival within the Delta and population dynamics of the stocks.

The estimated change in the risk of longfin smelt entrainment/salvage under CP2 compared with the Existing Condition and No-Action Alternative includes small positive and negative changes depending on water year type (Table 11-29). The increased risk of losses in drier years was considered to be potentially significant. These small changes in the risk of entrainment are considered to be less than significant in most water years, but potentially significant in critically dry years when juvenile longfin smelt production is typically low. The increased losses would also contribute to cumulative factors affecting survival of juvenile longfin smelt within the Delta.

The estimated change in the risk to steelhead of entrainment/salvage at the CVP and SWP export facilities under CP2 are summarized in Table 11-29. The small positive and negative changes in risk under most year types are considered to be less than significant. The increase in risk of steelhead losses in below-normal and critical water years (as compared with the Existing Condition) and in wet water years (as compared with the No-Action Alternative) is considered to be less than significant based on the abundance of juvenile Sacramento and San Joaquin river steelhead migrating through the Delta, but would contribute directly to cumulative factors affecting the survival and population dynamics of Central Valley steelhead. The increased risk of losses in drier years was considered to be potentially significant. The predicted increase in potential entrainment risk for steelhead under wet, below-normal, and critical water years represents an initial estimate of the change (percentage) between CP2 and the Existing Condition and the No-Action Alternative, and does not allow the predicted losses to be evaluated at the population level (see Attachment 1 of the *Fisheries and Aquatic Ecosystems Technical Report)*. The increased losses would also contribute to cumulative factors affecting survival of juvenile steelhead within the Delta.

The change in risk to juvenile striped bass for entrainment/salvage at the CVP and SWP export facilities is summarized in Table 11-29. The change in risk in all water years is considered to be less than significant for striped bass, but would contribute to the cumulative factors affecting striped bass survival and population dynamics in the Delta. The losses of juvenile striped bass increased substantially under dry and critical year conditions, which would be expected with an increase in exports during the summer months. The increased losses, particularly in drier water years when juvenile striped bass production is lower, would be expected to contribute to the cumulative effects of factors affecting juvenile striped bass survival in the Delta.

Results of the risk estimates for juvenile splittail losses show a pattern similar to other species (Table 11-29). The risk index would increase by less than 3 percent under CP2 compared to the Existing Condition or the No-Action Alternative. Higher risk of entrainment/salvage losses in drier water years has a potentially greater effect on abundance of juvenile splittail since reproductive success and overall juvenile abundance is typically lower within the Delta in dry years. The increased risk of losses in drier years was considered to be potentially significant. The increased losses would also contribute to cumulative factors affecting survival of juvenile splittail within the Delta.

Impact Aqua-23 (CP2) is considered to be less than significant for Chinook salmon, but potentially significant for delta smelt, steelhead, longfin smelt, striped bass, and splittail. Mitigation for this impact is not proposed because operations will be guided by RPAs established by NMFS and USFWS BOs to reduce any impacts to listed fish species, and will thus benefit non-listed fishes as well.

CVP/SWP Service Areas

Impact Aqua-24 (CP2): Impacts on Aquatic Habitats and Fish Populations in the CVP and SWP Service Areas Resulting from Modifications to Existing Flow Regimes CP2 implementation could result in modified flow regimes that would reduce the frequency and magnitude of high winter flows along the Sacramento River; however, the hydrologic effects to tributaries and reservoirs (e.g., New Melones and San Luis) with CVP and SWP dams, as well as the conveyances south of the Delta would be substantially less than impacts on the lower Sacramento River. The change in hydrology in the CVP and SWP service areas could affect aquatic habitats for the local resident fish community; however the changes would not result in substantial effects on their distribution or abundance. Therefore, this impact would be less than significant.

This impact would be similar to Impact Aqua-24 (CP1). The hydrologic effects to the CVP and SWP service areas would not result in substantial effects on the distribution or abundance of fish populations. The effects from CP2 on CVP and SWP reservoir elevations, filling, spilling, and planned releases, and the resulting flows downstream from those reservoirs would be small and well within range of variability that commonly occurs in these reservoirs and downstream, as described for Impact Aqua-24 (CP1). Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CP3 – 18.5-Foot Dam Raise, Agricultural Water Supply Reliability and Anadromous Fish Survival

CP3 focuses on increasing agricultural water supply reliability while also increasing anadromous fish survival. This plan primarily consists of raising Shasta Dam by 18.5 feet, which, in combination with spillway modifications, would increase the height of the reservoir's full pool by 20.5 feet and enlarge the total storage capacity in the reservoir by 634,000 acre-feet. The existing TCD would also be extended to achieve efficient use of the expanded cold-water pool. Because CP3 focuses on increasing agricultural water supply reliability, none of the increased storage capacity in Shasta Reservoir would be reserved for increasing M&I deliveries. Operations for water supply, hydropower, and environmental and other regulatory requirements would be similar to existing operations, with the additional storage retained for water supply reliability and to expand the cold-water pool for downstream anadromous fisheries.

Simulations of CP3 did not involve any changes to the modeling logic for deliveries or flow requirements; all rules for water operations were updated to include the new storage, but were not otherwise changed.

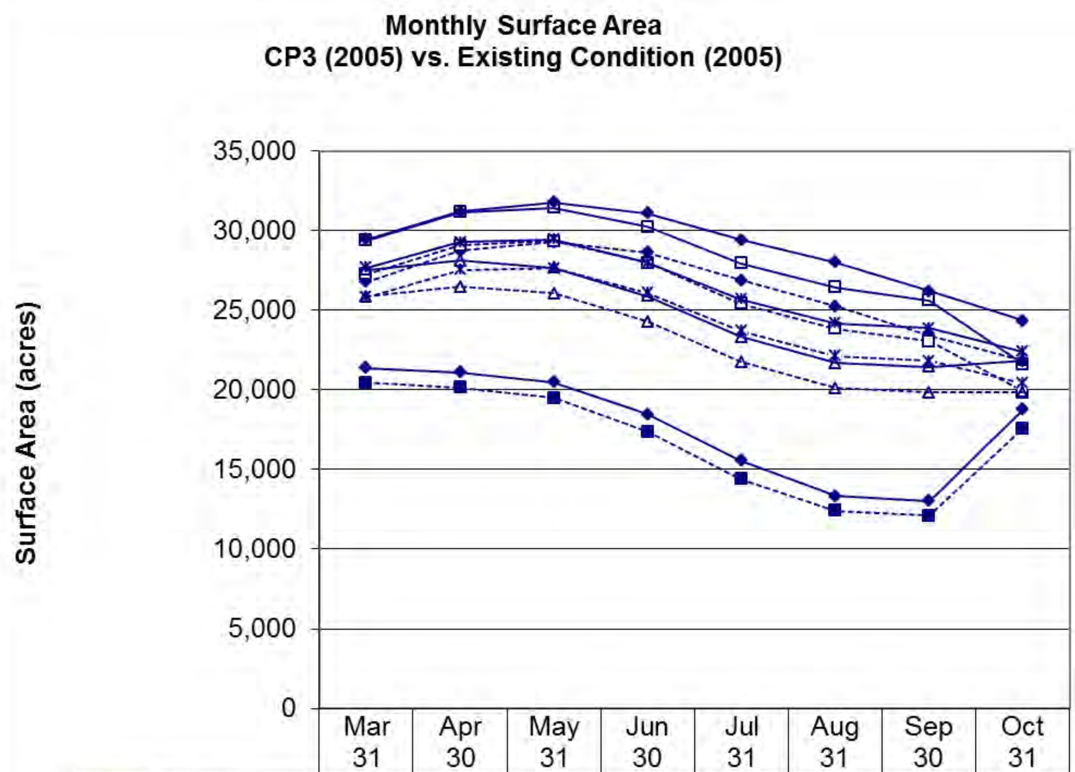
Shasta Lake and Vicinity

Impact Aqua-1 (CP3): Effects on Nearshore, Warm-Water Habitat in Shasta Lake from Project Operations Under CP3, project operations would contribute to an increase in the surface area and WSEL of Shasta Lake, which would in turn increase the area and productivity of nearshore, warm-water habitat. CP3 operations would also result in reduced monthly fluctuations in WSEL, which would contribute to increased reproductive success, young-of-the-year production, and the juvenile growth rate of warm-water fish species. Similar to CP-1, the value of existing structural habitat improvements would be diminished by deeper and longer periods of inundation to varying degrees; however, the existing habitat enhancement features would become functional during reservoir drawdowns later in the season and during below-normal and drier years; however, environmental commitments during construction, which include placing brush in the new inundation varial zone to extend and enhance existing fish habitat structures, would offset this effect (See Chapter 2, "Alternatives," for additional detailed descriptions of the environmental commitments). Additionally, large areas of the shoreline would not be cleared, and the vegetation along these sections would be inundated periodically. In the short term, this newly inundated vegetation will initially increase warm-water fish habitat, with decay expected to occur over several decades. This impact would be less than significant.

This impact would be similar to Impacts Aqua-1 (CP1 and CP2), but the surface area would be larger under the 18.5-foot dam raise than under the 6.5-foot and 12.5-foot dam raises. CalSim-II modeling shows that the surface area of Shasta Lake would be larger under CP3 for both a 2005 and a 2030 water supply demand than under the Existing Condition or the No-Action Alternative in all five water year types (Figures 11-24 and 11-25).

Monthly WSEL fluctuations were compared with projections for water supply demand. For CP3, with a 2005 water supply demand, 52 percent of monthly changes in projected WSELs (i.e., 13 of the 25 total projections made for the 5 months from March through July for all five water year types) showed decreased monthly WSEL fluctuations relative to the Existing Condition and 4 percent showed increased monthly WSEL fluctuations (Figure 11-26). For CP3, with a projected 2030 water supply demand, 52 percent of monthly changes in projected WSELs showed decreased WSEL fluctuations relative to the No-Action Alternative and 4 percent showed increased monthly WSEL fluctuations (Figure 11-27). Under CP3, none of the changes in monthly WSEL fluctuation are different enough from the Existing Condition to warrant the investigation of daily WSEL fluctuation.

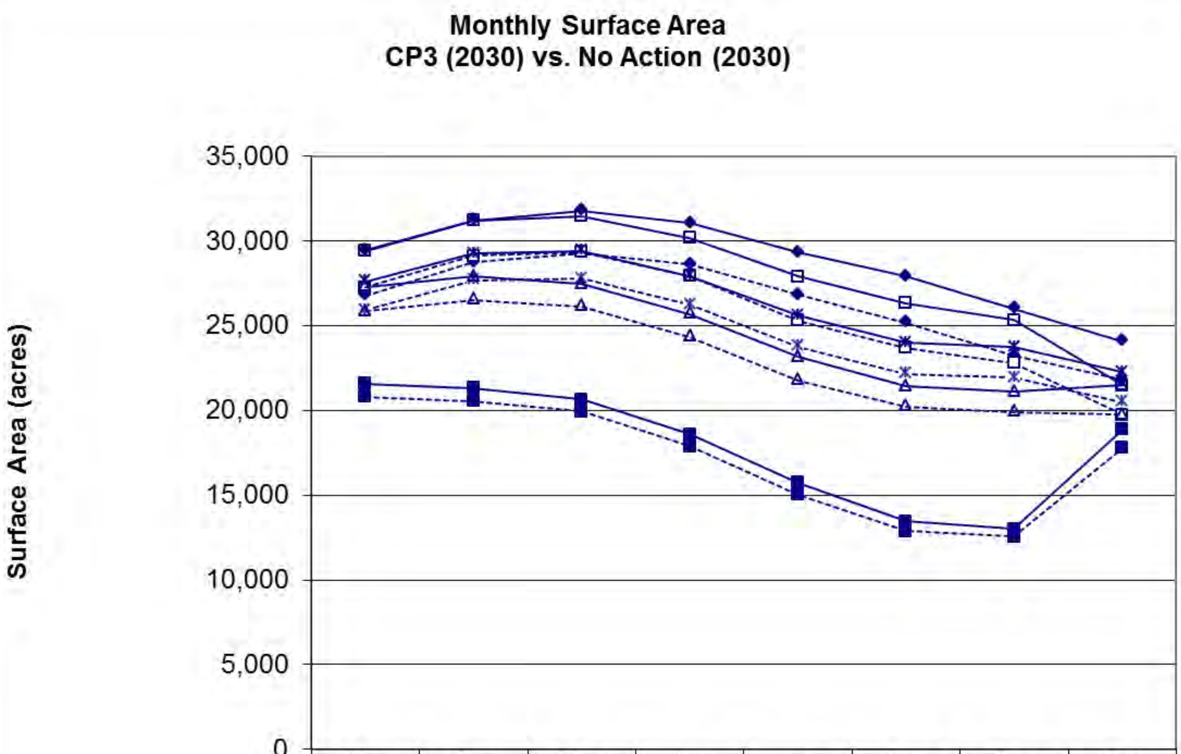
Increases in the overall surface area and WSEL under CP3 would increase the area of available warm-water habitat and stimulate biological productivity, including fish production, of the entire lake for a period of time, possibly for several decades. Furthermore, reductions in the magnitude of monthly WSEL fluctuations, along with the environmental commitment to install and extend existing habitat brush piles and structures, could contribute to increased reproductive success, young-of-the-year production, and juvenile growth rate of warm-water fish species. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.



	Mar 31	Apr 30	May 31	Jun 30	Jul 31	Aug 31	Sep 30	Oct 31
EC W	26,790	28,748	29,277	28,624	26,872	25,226	23,413	21,827
EC AN	27,245	29,082	29,336	27,992	25,400	23,826	23,061	19,906
EC BN	25,807	27,534	27,621	26,104	23,714	22,114	21,837	20,425
EC D	25,850	26,467	26,058	24,300	21,754	20,093	19,840	19,828
EC C	20,467	20,142	19,500	17,381	14,400	12,418	12,111	17,572
CP3 2005 W	29,448	31,208	31,794	31,080	29,401	28,015	26,214	24,345
CP3 2005 AN	29,386	31,151	31,444	30,225	27,957	26,440	25,635	21,622
CP3 2005 BN	27,659	29,270	29,441	27,996	25,675	24,184	23,889	22,404
CP3 2005 D	27,536	28,121	27,669	25,892	23,340	21,666	21,430	21,859
CP3 2005 C	21,390	21,110	20,501	18,455	15,567	13,341	13,013	18,761

Key:
AN = above-normal water
BN= below-normal water years
C = critical water years
CP = Comprehensive Plan
EC = Existing Condition
D = dry water years
W = wet water years

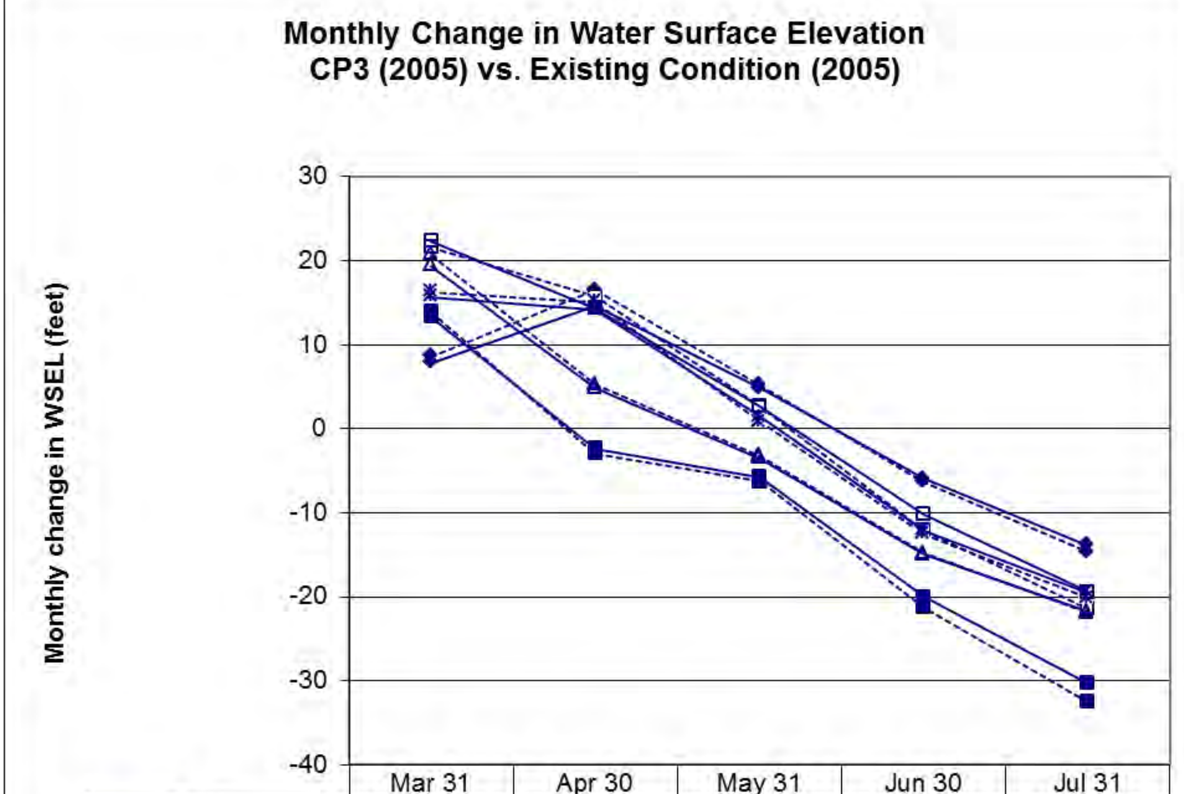
Figure 11-24. Average Monthly Surface Area for Each Water Year Type Within the Shasta Lake Vicinity of the Primary Study Area, CP3 Versus the Existing Condition



	Mar 31	Apr 30	May 31	Jun 30	Jul 31	Aug 31	Sep 30	Oct 31
NA W	26,775	28,735	29,273	28,604	26,797	25,183	23,205	21,808
NA AN	27,258	29,117	29,325	27,921	25,294	23,687	22,800	19,759
NA BN	25,918	27,662	27,770	26,239	23,764	22,137	21,923	20,469
NA D	25,843	26,514	26,134	24,346	21,780	20,209	19,910	19,728
NA C	20,801	20,548	19,942	17,866	15,026	12,873	12,556	17,800
CP3 2030 W	29,435	31,196	31,789	31,038	29,303	27,905	25,998	24,089
CP3 2030 AN	29,416	31,202	31,473	30,163	27,881	26,335	25,322	21,473
CP3 2030 BN	27,596	29,232	29,397	27,935	25,584	23,992	23,732	22,261
CP3 2030 D	27,290	27,887	27,450	25,672	23,146	21,416	21,087	21,492
CP3 2030 C	21,574	21,303	20,651	18,580	15,745	13,443	12,996	18,870

Key:
AN = above-normal water
BN= below-normal water years
C = critical water years
CP = Comprehensive Plan
D = dry water years
NA = No-Action
W = wet water years

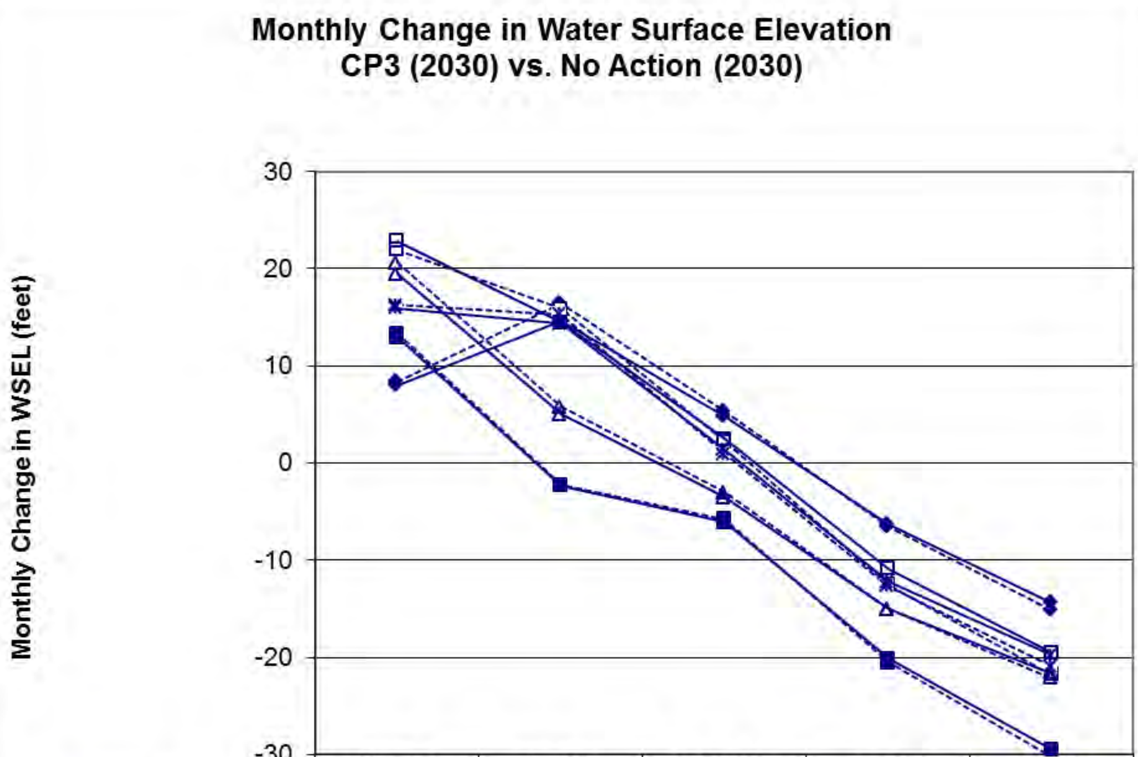
Figure 11-25. Average Monthly Surface Area for Each Water Year Type Within the Shasta Lake Vicinity of the Primary Study Area, CP3 Versus No-Action Alternative



	Mar 31	Apr 30	May 31	Jun 30	Jul 31
EC W	9	16	5	-6	-15
EC AN	22	16	3	-12	-21
EC BN	16	15	1	-13	-20
EC D	21	5	-3	-15	-22
EC C	14	-3	-6	-21	-32
CP3 (2005) W	8	15	5	-6	-14
CP3 (2005) AN	22	14	3	-10	-19
CP3 (2005) BN	16	14	1	-12	-20
CP3 (2005) D	19	5	-4	-15	-22
CP3 (2005) C	13	-2	-6	-20	-30

Key:
AN = above-normal water
BN= below-normal water years
C = critical water years
CP = Comprehensive Plan
D = dry water years
EC = Existing Condition
W = wet water years
WSEL = water surface elevation

Figure 11-26. Average Monthly Change in Water Surface Elevation for Each Water Year Type Within the Shasta Lake Vicinity of the Primary Study Area, CP3 Versus the Existing Condition



	Mar 31	Apr 30	May 31	Jun 30	Jul 31
NA W	8	16	5	-7	-15
NA AN	22	16	2	-13	-22
NA BN	16	15	1	-13	-21
NA D	21	6	-3	-15	-22
NA C	13	-2	-6	-21	-30
CP3 (2030) W	8	15	5	-6	-14
CP3 (2030) AN	23	15	2	-11	-20
CP3 (2030) BN	16	14	1	-12	-20
CP3 (2030) D	19	5	-4	-15	-22
CP3 (2030) C	13	-2	-6	-20	-29

Key:
AN = above-normal water
BN = below-normal water years
C = critical water years
CP = Comprehensive Plan
D = dry water years
NA = No-Action
W = wet water years
WSEL = water surface elevation

Figure 11-27. Average Monthly Change in Water Surface Elevation for Each Water Year Type Within the Shasta Lake Vicinity of the Primary Study Area, CP3 Versus No-Action Alternative

Impact Aqua-2 (CP3): Effects on Nearshore, Warm-Water Habitat in Shasta Lake from Project Construction Localized increases in soil erosion and resulting runoff sedimentation, and turbidity resulting from project construction in the vicinity of Shasta Dam and at utility, road, and other facility relocation areas could affect nearshore warm-water habitat. However, the environmental commitments for all action alternatives would result in less-than-significant impacts. Mitigation for this impact is not needed, and thus not proposed.

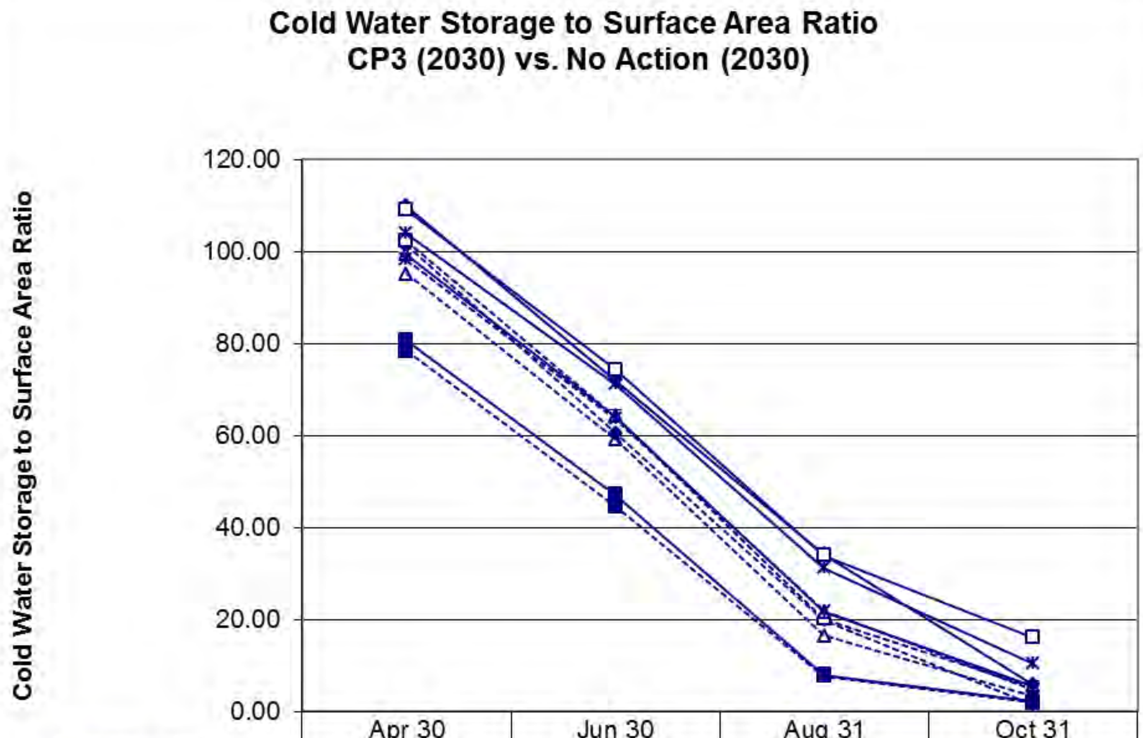
Impact Aqua-3 (CP3): Effects on Cold-Water Habitat in Shasta Lake Operations-related changes in the ratio of the volume of cold-water storage to surface area would increase the availability of suitable habitat for cold-water fish in Shasta Lake, including rainbow trout. This impact would be beneficial.

This impact would be similar to Impacts Aqua-3 (CP1 and CP2). However, it would be of greater magnitude owing to a greater increase in the ratio of the volume of cold-water storage in the lake to the surface area of the lake. CalSim-II modeling shows that under CP3 with a 2030 water supply demand, the ratio of cold-water storage to surface area is higher than under the No-Action Alternative in all water years and during all months modeled. The greatest projected increases over the No-Action Alternative occurred between June 30 and August 31, which is a critical rearing and oversummering period for cold-water fishes in reservoirs, and are greatest in wet, above-normal, and below-normal water years (Figure 11-28).

CP3 would increase the availability of suitable habitat for cold-water fish in Shasta Lake. Therefore, this impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Aqua-4 (CP3): Effects on Special-Status Aquatic Mollusks Under CP3, habitat for special-status mollusks could be inundated. Seasonal fluctuations in the surface area and WSEL of Shasta Lake could also adversely affect special-status aquatic mollusks that could occupy habitat in or near Shasta Lake and its tributaries. This impact would be similar to Impacts Aqua-4 (CP1 and CP2). However, a larger area would be inundated under CP3, which could result in an increase in impacts to these species and their habitat.

Except for the California floater, the occurrence of special-status mollusks in Shasta Lake and the lower reaches of its tributaries is unlikely. Modification or loss of suitable habitat for California floater would occur through increased WSEL and seasonal fluctuations in the surface area under CP3. Therefore, this impact would be potentially significant. Mitigation for this impact is proposed in Section 11.3.4, “Mitigation Measures.”



	Apr 30	Jun 30	Aug 31	Oct 31
NA W	101.33	60.49	19.89	1.43
NA AN	102.30	64.04	20.12	5.09
NA BN	98.27	63.71	21.84	4.64
NA D	95.13	59.14	16.50	3.38
NA C	78.43	44.58	7.66	1.82
CP3 2030 W	109.95	72.07	34.15	5.76
CP3 2030 AN	109.16	74.33	33.92	16.04
CP3 2030 BN	104.02	71.30	31.23	10.44
CP3 2030 D	99.41	64.23	21.58	5.57
CP3 2030 C	80.70	47.15	7.90	2.07

Key:
AN = above-normal water
BN= below-normal water years
C = critical water years
CP = Comprehensive Plan
D = dry water years
NA = No-Action
W = wet water years

Figure 11-28. Average Monthly Cold-water Storage to Surface Area Ratio for Each Water Year Type Within the Shasta Lake Vicinity of the Primary Study Area, CP3 Versus No-Action Alternative

Impact Aqua-5 (CP3): Effects on Special-Status Fish Species The expansion of the surface area of Shasta Lake and the inundation of additional tributary habitat under CP3 could affect one species designated as sensitive by USFS, the hardhead.

This impact would be similar to Impacts Aqua-5 (CP1 and CP2), but its magnitude would be greater owing to an increase in surface area and WSEL and expansion of the area subject to inundation. This impact would be less than significant.

Hardhead do not currently occur or are very uncommon in the primary tributaries to Shasta Lake, except in the Pit River above the Pit 7 Afterbay. Access to and the availability of suitable riverine habitat among all the main tributaries to the reservoir would not likely become any more limiting than under current conditions, nor would it greatly expand. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Aqua-6 (CP3): Creation or Removal of Barriers to Fish Between Tributaries and Shasta Lake Under CP3, project implementation would result in the periodic inundation of steep and low-gradient tributaries to Shasta Lake up to the 1,090-foot contour, the maximum inundation level under this alternative. This impact would be less than significant.

This impact would be similar to Impact Aqua-6 (CP2) (i.e., creation and elimination of fish passage barriers in tributaries to Shasta Lake would primarily be limited to non-fish-bearing intermittent streams). However, the maximum inundation level would be higher under CP3, which would inundate (eliminate) partial or complete fish barriers in approximately 13 more perennial tributaries than CP2.

Similar to CP2, implementation of CP3 could have small localized beneficial effects for adfluvial cold-water fishes and provide access to warm-water fish species, which would primarily be limited to the newly inundated reaches of the new varial zone of some streams. Impacts would not be expected to be much greater than under existing conditions. *Environmental commitments, described in Chapter 2, "Alternatives," to monitor fish communities in Squaw Creek and adaptively manage to prevent warmwater fish invasions would reduce this impact to a less than significant level.* Therefore, this impact is considered to be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Aqua-7 (CP3): Effects on Spawning and Rearing Habitat of Adfluvial Salmonids in Low-Gradient Tributaries to Shasta Lake CP3 would result in additional periodic inundation of potentially suitable spawning and rearing habitat for adfluvial salmonids (trout and land-locked salmon that spawn in streams and rear in lakes) in tributaries to Shasta Lake. It would also affect the character and location of substrate (e.g., spawning gravel) at some locations, influencing the suitability and availability of spawning and rearing habitat for adfluvial salmonids.

As described in Chapter 4, "Geology, Geomorphology, Minerals, and Soils,"CP3 would inundate perennial reaches with gradients of less than 7 percent that could provide spawning and rearing habitat for adfluvial salmonids. The lengths of low-gradient tributaries to each arm of Shasta Lake and estimated suitable spawning habitat areas (both intermittent and perennial) that would be periodically affected are as follows:

- Sacramento Arm – 4.0 miles (19,852 square feet, excludes mainstem river)
- McCloud Arm – 2.7 miles (13,601 square feet)
- Pit Arm – 1.9 miles (615 square feet, excludes mainstem river)
- Big Backbone Arm – 1.1 miles (175 square feet)
- Squaw Arm – 1.3 miles (1,300 square feet)

Eleven miles of low-gradient reaches that could potentially provide some spawning and rearing habitat for adfluvial salmonids (only about 2.8 percent of the low-gradient habitat upstream from Shasta Lake) would be affected by CP3. Although a small proportion of the total stream length would be affected by CP3, approximately 31,093 square feet of suitable cold-water spawning habitat, exclusive of mainstem habitat in the Sacramento and Pit rivers, was estimated to occur within the projected varial zone under CP3 during 2012 stream surveys.

This impact would be similar to Impacts Aqua-7 (CP1 and CP2); however, an additional 8,565 square feet (a total of 39,763 square feet) of suitable spawning habitat in low-gradient reaches to Shasta Lake would periodically be inundated. Therefore, this impact would be potentially significant. Mitigation for this impact is proposed in Section 11.3.4, "Mitigation Measures."

Impact Aqua-8 (CP3): Effects on Aquatic Connectivity in Non-Fish-Bearing Tributaries to Shasta Lake CP3 would result in periodic inundation of the lower reaches of high-gradient, intermittent non-fish-bearing tributaries to Shasta Lake. Twenty-four miles of non-fish-bearing tributary habitat (based on channel slope and confirmed by surveys of representative stream reaches) would be affected by CP3, which is only about 1 percent of the total length of non-fish-bearing tributaries upstream from Shasta Lake. Field surveys suggest that few, if any of the non-fish bearing streams contain special-status invertebrate or vertebrate species that would be affected by increased connectivity to Shasta Lake. This impact would be less than significant.

As described in Chapter 4, "Geology, Geomorphology, Minerals, and Soils," CP3 would inundate tributary segments with channel slopes in excess of 7 percent. Although these segments do not typically support salmonid populations, they do provide riparian and aquatic habitat for a variety of organisms and serve as corridors that connect habitat types. The lengths of non-fish-bearing tributaries for each arm of Shasta Lake that would be periodically inundated are as follows:

- Sacramento Arm – 5.5 miles
- McCloud Arm – 4.1 miles
- Pit Arm – 3.5 miles
- Big Backbone Arm – 2.7 miles
- Squaw Arm – 1.9 miles
- Main Body – 6.3 miles

This impact would be similar to Impacts Aqua-8 (CP1 and CP2). It would periodically inundate a larger amount of habitat than under CP1 and CP2, but the total amount inundated would be only 1 percent of the intermittent non-fish-bearing tributary habitat (based on channel slope) upstream from the lake. No special-status aquatic vertebrate or invertebrate species have been detected in these reaches. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Aqua-9 (CP3): Effects on Water Quality at Livingston Stone Hatchery Reclamation provides the water supply to the Livingston Stone Hatchery from a pipeline emanating from Shasta Dam. This supply would not be interrupted by any activity associated with CP3. There would be no impact.

This impact is the same as Impact Aqua-9 (CP1), and there would be no impact. Mitigation for this impact is not needed, and thus not proposed.

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact Aqua-10 (CP3): Loss or Degradation of Aquatic Habitat in the Upper Sacramento River during Construction Activities Temporary construction-related increases in sediments and turbidity levels would adversely affect aquatic habitats and fish populations immediately downstream in the upper Sacramento River. However, environmental commitments would be in place to reduce the effects. This impact would be less than significant.

This impact would be similar to Impact Aqua-10 (CP1). The impact could be greater under CP3 than under CP1 because of the increased activity associated with an 18.5-foot dam raise compared to a 6.5-foot dam raise. However, as under CP1, environmental commitments for all actions would be in place to reduce the effects. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Aqua-11 (CP3): Release and Exposure of Contaminants in the Upper Sacramento River During Construction Activities Construction-related activities could result in the release and exposure of contaminants. Such exposure could adversely affect aquatic habitats, the aquatic food web, and fish populations, including special-status species, downstream in the primary study area. However, environmental commitments would be in place to reduce the effects. Therefore, this impact would be less than significant.

This impact would be similar to Impact Aqua-11 (CP1). The impact could be greater under CP3 than under CP1 because of the increased activity associated with an 18.5-foot raise compared to a 6.5-foot raise. However, as under CP1, environmental commitments for all actions would be in place to reduce the effects. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Aqua-12 (CP3): Changes in Flow and Water Temperature in the Upper Sacramento River Resulting from Project Operation – Chinook Salmon and Steelhead CP3 operation would result in improved overall flow and water temperature conditions in the upper Sacramento River for Chinook salmon and steelhead as well as other native fishes. This impact would be beneficial.

Winter-Run Chinook Salmon

Production

Overall average winter-run production for the 82-year period would be similar (less than 5 percent change) for CP3 relative to the No-Action Alternative and the Existing Condition (Attachments 3 and 4 of the Modeling Appendix). The maximum increase in production relative to the No-Action Alternative was 121 percent for CP3, and the largest decrease in production relative to the No-Action Alternative was -14 percent (Table 11-30 and Attachment 3 of the Modeling Appendix). The maximum increase in production relative to the Existing Condition was 191 percent for CP3, and the largest decrease in production relative to the Existing Condition was -7 percent (Table 11-30 and Attachment 4 of the Modeling Appendix). Figure 11-9 shows the change in production relative to the No-Action Alternative for all water years and all Comprehensive Plans.

Under CP3, two critical and one dry water year had significant increases in production compared to the No-Action Alternative, while two critical and one above-normal water years had a significantly decreased production.

Table 11-30. Change in Production Under CP3 for Winter-Run Chinook Salmon

Year Type	Number of Years	Average Production	Change in Production from Baseline	Percent Change in Average Production	Maximum Percent Increase in Production	Number of Years with Significant Increase	Maximum Percent Decrease in Production	Number of Years with Significant Decrease
Future Condition (2030)								
All	**81**	**3,784,037**	**-17,078**	**-0.4**	**121.0**	**2**	**-14.1**	**3**
Critical	13	3,405,883	27,928	0.8	121.0	1	-14.1	2
Dry	17	3,989,211	16,880	0.4	6.9	1	-2.8	0
Below Normal	14	3,925,807	-12,751	-0.3	2.4	0	-3.6	0
Above Normal	11	3,804,872	-54,058	-1.4	1.2	0	-6.0	1
Wet	26	3,753,808	-48,470	-1.3	3.9	0	-4.3	0
Existing Condition (2005)								
All	81	3,788,864	7,618	0.2	191.4	6	-7.0	3
Critical	13	3,444,999	234,060	7.3	191.4	5	-4.1	0
Dry	17	3,980,152	-3,710	-0.1	14.3	1	-3.5	0
Below Normal	14	3,924,037	-16,112	-0.4	3.8	0	-3.3	0
Above Normal	11	3,795,459	-57,223	-1.5	0.7	0	-7.0	1
Wet	26	3,760,148	-57,987	-1.5	2.0	0	-6.4	2

Note:

Production is the number of immature smolts surviving to pass the Red Bluff Pumping Plant

Key:

CP = Comprehensive Plan

Under CP3, five out of 13 critical and one out of 17 dry water years had significant increases in production, compared to the Existing Condition. One above-normal (out of 11 years) and one wet (out of 26 years) water year had significant decreases in production.

Mortality

Mortality was separated by flow- and water temperature-related mortality to assess the level of impacts on winter-run Chinook salmon caused by the actions of the project (Attachments 3 and 4 of the Modeling Appendix). Nonoperations-related mortality is the base and seasonal mortality that would occur even without the effects of Shasta operations (such as disease, predation, and entrainment). Flow- and water temperature-related mortality is that caused by altering flow and water temperatures. In all cases, most mortality is caused by nonoperations-related factors (e.g., disease, predation, entrainment)−around 87 percent of the total mortality.

Mortality is presented in two manners–total mortality and smolt equivalent mortality (Attachments 3 and 4 of the Modeling Appendix). Under both 2030 and 2005 conditions, the greatest mortality to winter-run Chinook salmon under CP3 (as with CP1 and CP2) in all water year types, based on smolt equivalents, would occur to fry, then eggs, presmolts, immature smolts, and prespawn adults. Table 11-5 displays the overall mortalities for each Comprehensive Plan that would be caused by changes in water temperature and flow (see also Attachments 3 and 4 of the Modeling Appendix).

Years with the highest mortality were the same for the No-Action Alternative and CP3. Each of these years was a critical water year, and was preceded by either a critical (1933, 1976, 1991) or dry (1930 and 1932) water year type (Attachments 3 and 4).

Winter-run Chinook salmon would have, overall, an insignificant change in project-related mortality relative to No-Action Alternative, but significant compared with the Existing Condition. They would also have an insignificant change in production (including in critical water years), winter-run Chinook salmon would have a less-than-significant impact from actions taken in CP3. Mitigation for this impact is not needed, and thus not proposed.

Spring-Run Chinook Salmon

Production

Overall average spring-run Chinook salmon production for the 81-year period remained relatively similar (less than 5 percent change) to the No-Action Alternative and Existing Condition. The maximum increase in production relative to the No-Action Alternative was 123 percent for CP3 in a dry water year, while the largest decrease in production was almost 44 percent in a critical water year (Table 11-31 and Attachment 6 of the Modeling Appendix). The maximum increase in production relative to the Existing Condition was 602 percent for CP3. The largest decrease in production relative to the Existing

Condition was 9 percent for CP3 (Table 11-31 and Attachment 7 of the Modeling Appendix). Figure 11-10 shows the change in production relative to the No-Action Alternative for all water years and all Comprehensive Plans.

Under CP3, five critical, one dry, and one below-normal water years had significant increases in production compared to the No-Action Alternative, while two critical water years had significant decreases in production (Attachment 6 of the Modeling Appendix).

Under CP3, eight critical, one dry, and one below-normal water years had significant increases in production compared to the Existing Condition. Only one critical water year had a significant decrease in production (Attachment 7 of the Modeling Appendix).

Table 11-31. Change in Production Under CP3 for Spring-Run Chinook Salmon

Year Type	Number of Years	Average Production	Change in Production from Baseline	Percent Change in Average Production	Maximum Percent Increase in Production	Number of Years with Significant Increase	Maximum Percent Decrease in Production	Number of Years with Significant Decrease
Future Condition (2030)								
All	81	163,036	-1,019	-0.6	123	7	-43.8	3
Critical	13	82,081	892	1.1	86.1	5	-43.8	2
Dry	17	170,498	1,046	0.6	123	1	-2.2	0
Below Normal	14	177,547	366	0.2	20.7	1	-3.4	0
Above Normal	11	181,387	-2,378	-1.3	4.9	0	-3.5	0
Wet	26	183,056	-3,495	-1.9	1.5	0	-5.1	1
Existing Condition (2005)								
All	81	164,298	1,090	0.7	602	10	-8.7	2
Critical	13	89,222	15,160	20.5	602	8	-8.7	1
Dry	17	169,946	1,084	0.6	243	1	-2.8	0
Below Normal	14	178,606	577	0.3	30.4	1	-3.6	0
Above Normal	11	181,593	-2,520	-1.4	3.0	0	-3.1	0
Wet	26	183,120	-4,138	-2.2	2.3	0	-5.1	1

Note:
Production is the number of immature smolts surviving to pass the Red Bluff Pumping Plant

Key:
CP = Comprehensive Plan

Mortality

Mortality was separated by flow- and water temperature-related mortality to assess the level of impacts on spring-run Chinook salmon caused by the actions of the project (Attachments 6 and 7). In all cases, most mortality is caused by nonoperations-related factors (e.g., disease, predation, entrainment)−about 83 percent of the total mortality.

Mortality is presented in two manners–total mortality and smolt equivalent mortality (Attachments 6 and 7 of the Modeling Appendix). Under both 2030 and 2005 conditions, the greatest mortality to spring-run Chinook salmon under CP3 (as with CP1 and CP2) in all water year types based on smolt equivalents, would occur to the eggs, then fry, followed by presmolts and lastly immature smolts. Nonoperational conditions would be the primary causes of mortality for all life stages under all Comprehensive Plans. Table 11-7 displays the smolt-equivalent mortalities for each Comprehensive Plan changes in water temperature and flow (Attachments 6 and 7 of the Modeling Appendix).

Years with the highest operations-related mortality were the same CP3, No-Action Alternative and the Existing Condition. These were each preceded by a critical or dry water year. However, years with the lowest mortality varied between all water year types (Attachments 6 and 7).

Because spring-run Chinook salmon have, overall, a significant reduction in project-related mortality under both 2030 and 2005 conditions, but insignificant increase in overall production. However, spring-run Chinook salmon would have a significant increase in production during critical water years–those years in which they are at greatest risk. Therefore, spring-run Chinook salmon would benefit from actions taken in CP3. Mitigation for this impact is not needed, and thus not proposed.

Fall-Run Chinook Salmon

Production

Overall average fall-run Chinook salmon production for the 81-year period was similar between CP3 and the No-Action Alternative and the Existing Condition (Attachments 9 and 10 of the Modeling Appendix). The maximum increase in production relative to the No-Action Alternative was 41 percent (below-normal water year) for CP3, while the largest decrease in production relative to the No-Action Alternative was around -14 percent (in a critical water year) (Table 11-32 and Attachment 9 of the Modeling Appendix). The maximum increase in production relative to the Existing Condition was just around 144 percent for CP3 in a critical water year, and the largest decrease in production relative to the Existing Condition was –less than 7 percent in a wet water year (Table 11-32 and Attachment 10 of the Modeling Appendix). Figure 11-11 shows the change in production relative to the No-Action Alternative for all water years and all Comprehensive Plans.

Table 11-32. Change in Production Under CP3 for Fall-Run Chinook Salmon

Year Type	Number of Years	Average Production	Change in Production from Baseline	Percent Change in Average Production	Maximum Percent Increase in Production	Number of Years with Significant Increase	Maximum Percent Decrease in Production	Number of Years with Significant Decrease
Future Conditions (2030)								
All	81	29,737,538	219,131	0.7	40.9	12	-13.8	3
Critical	13	26,803,488	358,660	1.4	17.1	5	-13.8	1
Dry	17	30,186,998	646,837	2.2	19.8	5	-4.7	0
Below Normal	14	31,748,386	650,475	2.1	40.9	2	-5.9	1
Above Normal	11	30,879,929	-153,081	-0.5	4.9	0	-2.9	0
Wet	26	29,344,601	-205,074	-0.7	4.7	0	-6.4	1
Existing Condition (2005)								
All	81	29,905,352	477,011	1.6	144	13	-6.8	3
Critical	13	27,963,775	1,787,639	6.8	144	6	-1.6	0
Dry	17	30,111,299	650,898	2.2	25.3	4	-3.6	0
Below Normal	14	31,784,514	766,252	2.5	59.4	2	-6.7	1
Above Normal	11	30,762,948	-107,448	-0.3	3.6	0	-3.3	0
Wet	26	29,366,799	-200,472	-0.7	5.9	1	-6.8	2

Note:

Production is the number of immature smolts surviving to pass the Red Bluff Pumping Plant

Key:

CP = Comprehensive Plan

In critical, dry, and below-normal water years, when production was lowest over the simulation period, the increase in production resulting from operations-related activities was greatest. In above-normal and wet water years, however, the lowest production years typically had a slight decrease in production under CP1 conditions relative to the No-Action Alternative (Attachments 9 and 10 of the Modeling Appendix).

Under CP3, five critical, five dry, and two below-normal water years had significant increases in production relative to the No-Action Alternative. Significant decreases in production occurred in one critical, one below-normal, and one wet water year (Attachment 9 of the Modeling Appendix).

Under CP3, six critical, four dry, two below-normal, and one wet water year had significant increases in production relative to the Existing Condition. Significant reductions in production occurred in one below-normal, and two wet water years (Attachment 10 of the Modeling Appendix).

Mortality

Mortality was separated by flow- and water temperature-related mortality to assess the level of impacts on fall-run Chinook salmon caused by the actions of the project (Attachments 9 and 10). In all cases, most mortality is caused by nonoperations-related factors (e.g., disease, predation, entrainment)−around 65 percent of the total mortality.

Mortality is presented in two manners–total mortality and smolt equivalent mortality (Attachments 9 and 10 of the Modeling Appendix). Under both 2030 and 2005 conditions, the greatest mortality based on the smolt equivalents to fall-run Chinook salmon under CP3 (as with CP1 and CP2) occurs to fry, followed by egg, prespawn adults, presmolts, and lastly to immature smolts. Table 11-9 displays the overall mortalities for each Comprehensive Plan that were caused by changes in water temperature and flow (see also Attachments 9 and 10 of the Modeling Appendix).

There was no real trend with respect to years with the greatest mortality. Years with the lowest production were in all water years except above-normal water years, and were preceded by all water year types.

Fall-run Chinook salmon have a significant reduction in project-related mortality under CP3 but an insignificant increase in average production. However, fall-run Chinook salmon would benefit from actions taken in CP3, experiencing a significant increase in 15 percent of the years. Mitigation for this impact is not needed, and thus not proposed.

Late Fall-Run Chinook Salmon and Steelhead

Late fall-run Chinook salmon were evaluated directly using SALMOD and were considered to be a surrogate for steelhead; therefore, the following discussion regarding SALMOD results for late fall-run Chinook salmon are applicable to steelhead.

Production
Overall average late fall-run Chinook salmon production for the 80-year period was similar to CP3 and the No-Action Alternative and the Existing Condition (Attachments 12 and 13 of the Modeling Appendix). The maximum increase in production relative to the No-Action Alternative was 12 percent in a dry water year for CP3, while the largest decrease in production relative to the No-Action Alternative was less than 5 percent for CP3 (Table 11-33 and Attachment 12 of the Modeling Appendix). The maximum increase in production relative to the Existing Condition was almost 13 percent for CP3 (in a dry water year), while the largest decrease in production relative to the Existing Condition was less than -5 percent (Table 11-33 and Attachment 13 of the Modeling Appendix). Figure 11-12 shows the change in production relative to the No-Action Alternative for all water years and all Comprehensive Plans.

Under CP3, one critical and two dry water years had significant increases in production compared to the No-Action Alternative, and there were no significant decreases in production.

Table 11-33. Change in Production Under CP3 for Late Fall-Run Chinook Salmon

Year Type	Number of Years	Average Production	Change in Production from Baseline	Percent Change in Average Production	Maximum Percent Increase in Production	Number of Years with Significant Increase	Maximum Percent Decrease in Production	Number of Years with Significant Decrease
Future Condition (2030)								
All	80	7,424,900	6,413	0.1	12.1	3	-4.9	0
Critical	13	7,107,373	43,205	0.6	7.5	1	-2.9	0
Dry	16	7,390,273	35,904	0.5	12.1	2	-4.9	0
Below Normal	14	7,599,738	-12,880	-0.2	2.4	0	-3.2	0
Above Normal	11	7,583,369	-2,715	0.0	1.7	0	-3.0	0
Wet	26	7,443,783	-15,881	-0.2	4.4	0	-3.9	0
Existing Condition (2005)								
All	80	7,422,929	36,368	0.5	12.9	5	-4.7	0
Critical	13	7,054,205	90,909	1.3	12.2	2	-3.4	0
Dry	16	7,398,822	38,554	0.5	12.9	3	-4.7	0
Below Normal	14	7,632,250	21,156	0.3	3.3	0	-2.6	0
Above Normal	11	7,593,708	34,035	0.5	2.6	0	-1.2	0
Wet	26	7,437,163	16,932	0.2	3.5	0	-4.0	0

Note:

Production is the number of immature smolts surviving to pass the Red Bluff Pumping Plant

Late fall-run Chinook salmon are used as a surrogate for steelhead

Key:

CP = Comprehensive Plan

Under CP3, two critical and three dry water years had significant increases in production compared to the Existing Condition, and there were no significant decreases in production.

Mortality

Mortality was separated by flow- and water temperature-related mortality to assess the level of impacts on late fall-run Chinook salmon caused by the actions of the project (Attachments 12 and 13 of the Modeling Appendix). In all cases, most mortality is caused by nonoperations-related factors (e.g., disease, predation, entrainment)−around 78 percent of the total mortality.

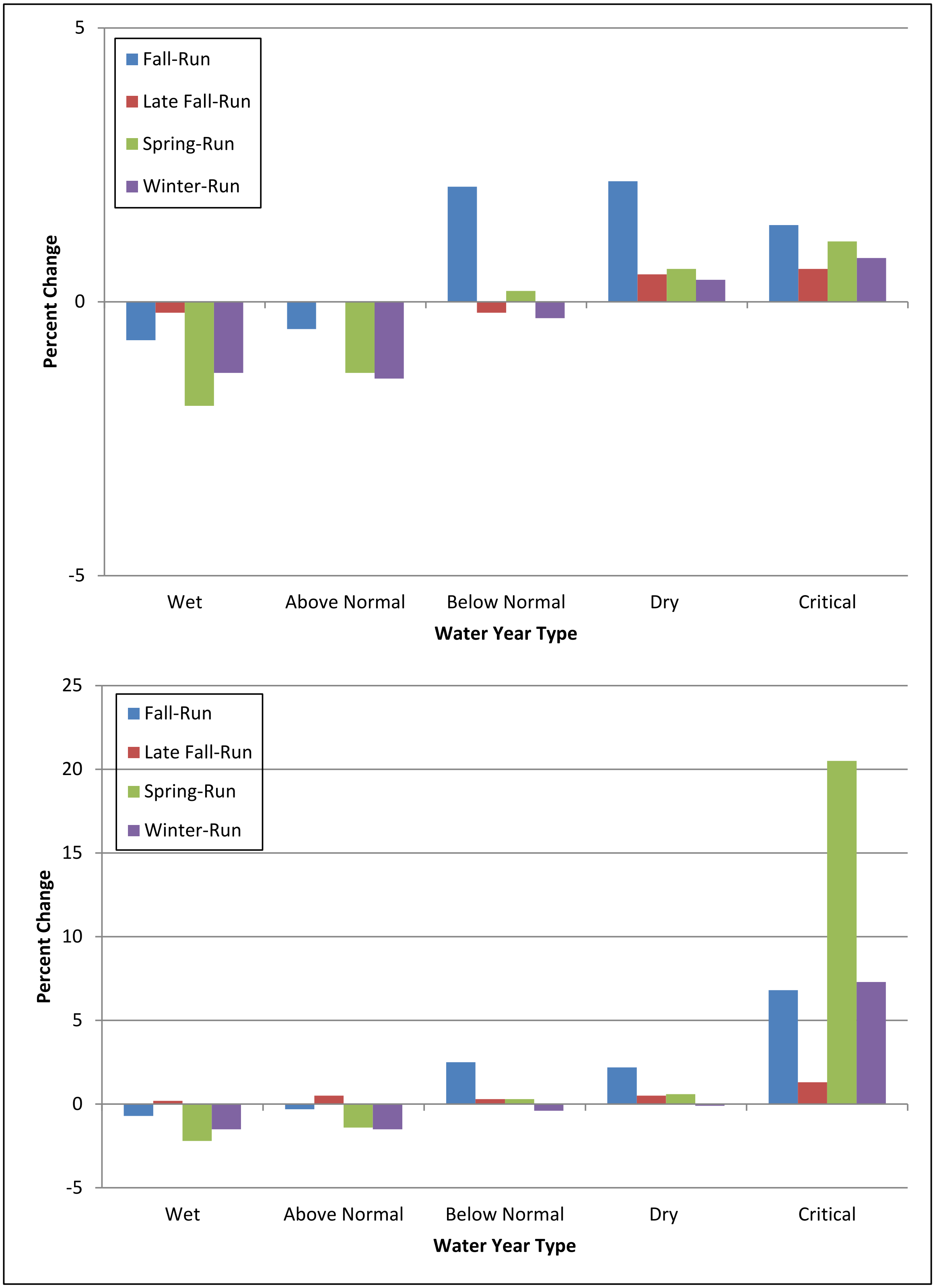
Mortality is presented in two manners–total mortality and smolt equivalent mortality (Attachments 12 and 13 of the Modeling Appendix). Under both 2030 and 2005 conditions, the greatest mortality to late fall-run under CP3 (as with CP1 and CP2) in all water year types based on smolt equivalents, would occur to fry, then eggs, presmolts, immature smolts, and lastly to prespawn adults. Table 11-11 displays the overall mortalities for each Comprehensive Plan that were caused by changes in water temperature and flow) (Attachments 12 and 13 of the Modeling Appendix).

Years with the highest mortality were the same for CP3, the No-Action Alternative and Existing Conditions. All water year types were covered. Two years were preceded by a wet water year, one preceded by an above-normal water year, and two by a below-normal water year (Attachments 12 and 13 of the Modeling Appendix).

Because SALMOD indicates an insignificant change in mortality and production index for late fall-run Chinook salmon, late fall-run Chinook salmon and steelhead (as represented by their surrogate, late fall-run Chinook salmon) would experience a less-than-significant impact from actions taken in CP3. Mitigation for this impact is not needed, and thus not proposed.

All Chinook Runs Combined

Raising Shasta Dam by 18.5 feet, in conjunction with spillway modifications, would result in an increase in full pool depth of 20.5 feet and an additional 634,000 acre-feet of storage capacity in Shasta Reservoir. The additional storage created by the dam raise would be used to improve the ability to meet water temperature objectives and habitat requirements for anadromous fish during drought years (see Figure 11-29). Under the 2030 conditions, overall production for all four runs of Chinook salmon combined would increase by over 207,000 immature smolts migrating below RDPP. Under the 2005 conditions, overall production for all four runs of Chinook salmon combined would increase by almost 522,000 immature smolts migrating below RDPP.



Note: Changes in outmigrating Chinook salmon simulated using SALMOD; Water Year Types based on the Sacramento Valley Water Year Hydrologic Classification

Figure 11-29. Percent Change in Production of Chinook Salmon for CP3 Compared to the No-Action Alternative (top) and Existing Conditions (bottom)

Impact Aqua-13 (CP3): Changes in Flow and Water Temperatures in the Upper Sacramento River Resulting from Project Operation – Steelhead, Green Sturgeon, Sacramento Splittail, American Shad, and Striped Bass CP3 operation generally would result in slightly improved flow and water temperature conditions in the upper Sacramento River for steelhead, green sturgeon, Sacramento splittail, American shad, and striped bass. This impact would be less than significant.

This impact would be similar to Impact Aqua-13 (CP1). The impact could be greater under CP3 than under CP1 because of the increased reservoir capacity associated with an 18.5-foot raise compared to a 6.5-foot raise.

Flow-Related Effects As under CP1, monthly mean flows at all modeling locations along the upper Sacramento River (below Shasta Dam, below Keswick Dam, above Bend Bridge, and above RBPP) under CP3 would generally be equivalent to (less than 5-percent difference from) flows under the Existing Condition and No-Action Alternative conditions simulated for all months. (See the Modeling Appendix for complete modeling results.)

Potential flow-related effects of CP3 on fish species of management concern in the upper Sacramento River would be minimal. Potential changes in flows and stages would diminish rapidly downstream from RBPP because of increased effects from tributary inflows, diversions, and flood bypasses.

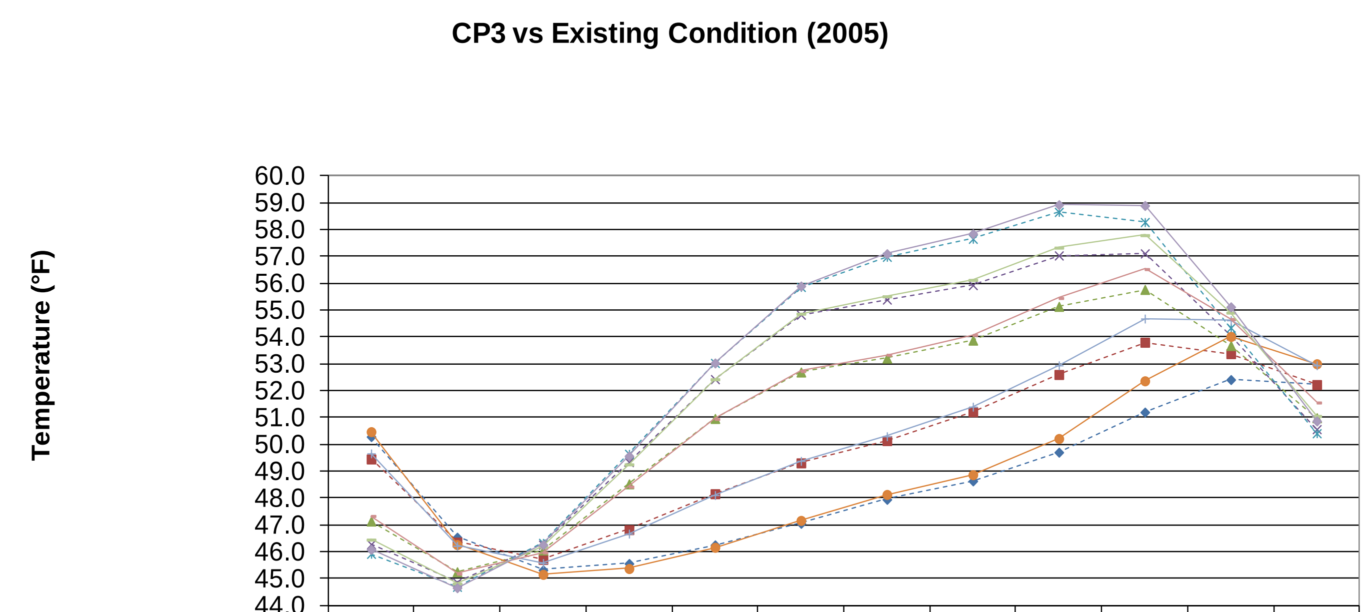
Changes in monthly mean flows under CP3 relative to the Existing Condition and No-Action Alternative would have no discernible effects on steelhead, green sturgeon, Sacramento splittail, American shad, or striped bass in the upper Sacramento River. Functional flows for migration, attraction, spawning, egg incubation, and rearing/emigration for these species would be unchanged. Flow-related effects on these fish species would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Water Temperature–Related Effects As under CP1, monthly mean water temperatures at all modeling locations along the upper Sacramento River (below Shasta Dam, below Keswick Dam, Balls Ferry, above Bend Bridge, and above RBPP) under CP3 would be the same as, or fractionally lower than, water temperatures under the Existing Condition and No-Action Alternative simulated for all months (Figures 11-30 and 11-31). See the Modeling Appendix for complete modeling results.

As discussed above, the modeling simulations may not fully account for real time management of the cold-water pool and TCD (through the SRTTG) to achieve maximum cold-water benefits. Therefore, the modeled changes in water temperature (i.e., small benefits) are likely conservative and understated to some degree. Potential water temperature–related effects of CP3 on fish species of management concern in the upper Sacramento River would be minimal. During most years, annual releases from Shasta Dam would be unchanged.

Potential changes in flows and stages would diminish downstream from RBPP because of the increasing effect from tributary inflows, diversions, and flood bypasses.

The slightly cooler monthly mean water temperatures under CP3 relative to the Existing Condition and the No-Action Alternative would have very small effects on steelhead, green sturgeon, Sacramento splittail, American shad, or striped bass in the upper Sacramento River. Monthly mean water temperatures would not rise above important thermal tolerances for the species life stages relevant to the upper Sacramento River. Therefore, water temperature–related effects on these fish species would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

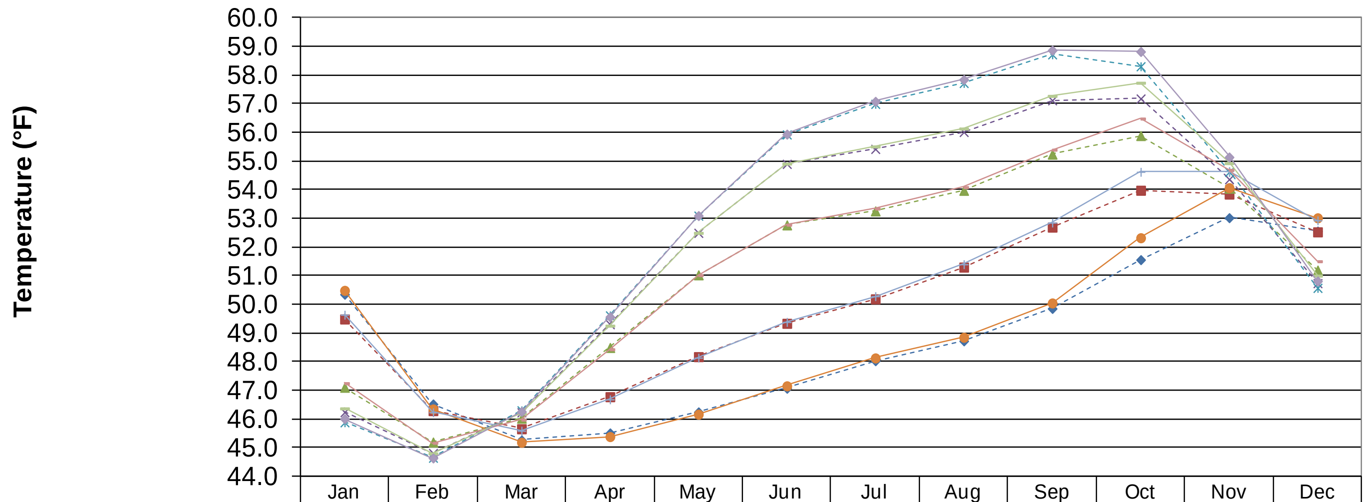


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CP3 Below Shasta	50.3	46.5	45.3	45.6	46.3	47.1	48.0	48.6	49.7	51.2	52.4	52.2
CP3 Below Keswick	49.5	46.4	45.7	46.8	48.2	49.3	50.1	51.2	52.6	53.8	53.4	52.2
CP3 Balls Ferry	47.1	45.3	46.1	48.5	51.0	52.7	53.2	53.9	55.1	55.8	53.7	51.0
CP3 Bend Bridge	46.3	44.9	46.3	49.3	52.4	54.8	55.4	55.9	57.0	57.1	54.1	50.6
CP3 RBPP	45.9	44.7	46.3	49.6	53.0	55.9	57.0	57.7	58.7	58.3	54.3	50.4
EC Below Shasta	50.5	46.3	45.2	45.4	46.2	47.2	48.1	48.9	50.2	52.4	54.0	53.0
EC Below Keswick	49.7	46.2	45.6	46.7	48.1	49.4	50.3	51.4	52.9	54.7	54.6	52.9
EC Balls Ferry	47.3	45.2	46.0	48.4	50.9	52.7	53.3	54.1	55.4	56.5	54.7	51.6
EC Bend Bridge	46.5	44.8	46.2	49.3	52.4	54.9	55.5	56.1	57.3	57.8	54.9	51.1
EC RBPP	46.1	44.7	46.3	49.6	53.0	55.9	57.1	57.8	58.9	58.9	55.1	50.9

Key: °F = degrees Fahrenheit EC = Existing Condition
CP = Comprehensive Plan RBPP = Red Bluff Pumping Plant

Figure 11-30. Changes in Mean Monthly Water Temperature at Modeled Locations in the Sacramento River Within the Primary Study Area (CP3 Versus Existing Condition)

CP3 vs No-Action (2030)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CP3 Below Shasta	50.4	46.5	45.3	45.5	46.2	47.1	48.0	48.7	49.9	51.6	53.0	52.6
CP3 Below Keswick	49.5	46.3	45.7	46.8	48.2	49.3	50.2	51.3	52.7	54.0	53.8	52.5
CP3 Balls Ferry	47.1	45.2	46.0	48.5	51.0	52.8	53.3	54.0	55.2	55.9	54.0	51.2
CP3 Bend Bridge	46.2	44.8	46.2	49.3	52.5	54.9	55.4	56.0	57.1	57.2	54.4	50.7
CP3 RBPP	45.9	44.7	46.3	49.6	53.1	55.9	57.0	57.7	58.7	58.3	54.6	50.6
NA Below Shasta	50.5	46.3	45.2	45.4	46.2	47.2	48.1	48.9	50.0	52.3	54.1	53.0
NA Below Keswick	49.6	46.2	45.6	46.7	48.1	49.4	50.3	51.4	52.9	54.6	54.6	52.9
NA Balls Ferry	47.3	45.2	46.0	48.4	51.0	52.8	53.3	54.1	55.4	56.5	54.7	51.5
NA Bend Bridge	46.4	44.8	46.2	49.3	52.5	54.9	55.5	56.1	57.3	57.7	54.9	51.0
NA RBPP	46.0	44.6	46.3	49.6	53.1	55.9	57.1	57.8	58.9	58.8	55.1	50.8

Key: °F = degrees Fahrenheit NA = No-Action
CP = Comprehensive Plan RBPP = Red Bluff Pumping Plant

Figure 11-31. Changes in Mean Monthly Water Temperature at Modeled Locations in the Sacramento River Within the Primary Study Area (CP3 Versus No-Action Alternative)

Impact Aqua-14 (CP3): Reduction in Ecologically Important Geomorphic Processes in the Upper Sacramento River Resulting from Reduced Frequency and Magnitude of Intermediate to High Flows Project operations could cause a reduction in the magnitude, duration, and frequency of intermediate to large flows both in the upper Sacramento River and in the lowermost (confluence) areas of tributaries. Such flows are necessary for channel forming and maintenance, meander migration, and the creation of seasonally inundated floodplains. These geomorphic processes are ecologically important because they are needed to maintain important aquatic habitat functions and values for fish and macroinvertebrate communities. This impact would be potentially significant.

This impact would be similar to Impact Aqua-14 (CP1). The impact could be greater under CP3 than under CP1 because the increased reservoir capacity associated with an 18.5-foot raise compared to a 6.5-foot raise would allow for storage of additional water volume (and flows) behind the raised dam.

Sediment transport, deposition, and scour regulate the formation of key habitat features such as point bars, gravel deposits, and SRA habitat. Intermediate to high flows and the associated stage elevation of the river surface also provide a backwater effect on the lowermost segment of tributaries, reducing the potential for downcutting. These processes are regulated by the magnitude and frequency of flow. Relatively large flows provide the energy required to mobilize sediment from the riverbed, produce meander migration, increase stage elevation, and create seasonally inundated floodplains. Operations under CP3 could result in a reduction in the intermediate to large flows necessary for channel forming and maintenance, meander migration, and the creation of seasonally inundated floodplains.

Implementation of CP3 would cause a further reduction in the magnitude, duration, and frequency of intermediate to large flows, relative to the Existing Condition and No-Action Alternative. Overall, the project would increase the existing, ongoing effects on geomorphic processes resulting from operation of Shasta Dam that are necessary for channel forming and maintenance, meander migration, and the creation of seasonally inundated floodplains. These effects would likely occur throughout the upper Sacramento River portion of the primary study area.

Reductions in the magnitude of high flows would likely be sufficient to reduce ecologically important processes along the upper Sacramento River, downstream from Shasta Dam, throughout the primary study area. This impact would be potentially significant. Mitigation for this impact is proposed in Section 11.3.4, “Mitigation Measures.”

Lower Sacramento River and Delta

Impact Aqua-15 (CP3): Changes in Flow and Water Temperatures in the Lower Sacramento River and Tributaries and Trinity River Resulting from Project Operation – Fish Species of Primary Management Concern Project operation would result in no discernible change in monthly mean flows or water temperature conditions in the lower Sacramento River. However, predicted changes in flows in the Feather, American, and Trinity rivers could result in adverse effects on Chinook salmon, steelhead, Coho salmon, green sturgeon, Sacramento splittail, American shad, and striped bass. This impact would be potentially significant.

This impact would be similar to Impact Aqua-15 (CP1). The impact could be greater under CP3 than under CP1 because the increased reservoir capacity associated with an 18.5-foot raise compared to a 6.5-foot raise would allow for storage of additional water volume (and increased cold-water pool) behind the raised dam.

As described below, mean monthly flows at various modeling locations on the lower Sacramento River and tributaries under CP3 were compared with mean monthly flows simulated for Existing Conditions and No-Action Alternative conditions. See the Modeling Appendix for complete CalSim-II modeling results.

Lower Sacramento River As under CP1, monthly mean flows at the lower Sacramento River modeling locations under CP3 would be comparable to flows under the Existing Condition and No-Action Alternative conditions simulated for all months. Differences in monthly mean flow were generally small (less than 2 percent) and within the existing range of variability. Potential changes in flows diminished rapidly downstream from RBPP because of the increasing effect from tributary inflows, diversions, and flood bypasses. Similarly, potential changes in water temperatures in the lower Sacramento River caused by small changes in releases would diminish rapidly downstream because of the increasing effect of inflows, atmospheric influences, and groundwater. Therefore, flow- and temperature-related impacts on fish species in the lower Sacramento River would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Also, as under CP1, the effects of altered flow regimes resulting from implementation of CP3 are unlikely to extend into the lower Sacramento River and Delta because the Central Valley's reservoirs and diversions are managed as a single integrated system (consisting of the SWP and the CVP). The operational requirements, including the USFWS BO and the 2009 NMFS BO, have been designed to maintain standards for flow to the lower Sacramento River and Delta. CVP and SWP operations must be consistent with these ESA BOs. Thus, implementation of CP3 would not likely alter flow to the Delta or water temperatures in the lower Sacramento River and its primary tributaries to a degree sufficient to affect Chinook salmon, steelhead, green sturgeon, Sacramento splittail, American shad, or striped bass relative to the Existing Condition and No-Action Alternative. Functional flows for fish migration, attraction, spawning, egg incubation, and rearing/emigration for all these fish species would be unchanged. Therefore, flow- and water temperature–related effects on these fish species would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Lower Feather River, American River, and Trinity River Also, as under CP1, monthly mean flows at modeling locations on the lower Feather River, the American River, and the Trinity River under CP3 would generally be equivalent to (less than 2-percent difference from) flows under the Existing Condition and No-Action Alternative simulated for most months. However, simulations for several months within the modeling record showed substantial changes to flows in tributaries. Potential changes in flows could be reduced by real-time operations to meet existing rules and because of operation of upstream reservoirs (Lake Oroville, Folsom Lake, and Trinity Lake) and increasing effects from tributary inflows, diversions, and flood bypasses. Potential changes in water temperatures in the Feather River and American River caused by altered releases from reservoirs could diminish downstream because of the increasing effect of inflows, and atmospheric and groundwater influences. Nevertheless, based on predicted changes in flow and associated flow-habitat relationships, potential flow-related impacts on species of management concern in the American, Feather, and Trinity rivers could occur. This impact would be potentially significant. Mitigation for this impact is proposed in Section 11.3.4, "Mitigation Measures."

Impact Aqua-16 (CP3): Reduction in Ecologically Important Geomorphic Processes in the Lower Sacramento River Resulting from Reduced Frequency and Magnitude of Intermediate to High Flows Project operation could cause a reduction in intermediate to large flows both in the lower Sacramento River and in the lowermost (confluence) areas of tributaries. Such flows are necessary for channel forming and maintenance, meander migration, and the creation of seasonally inundated floodplains. These geomorphic processes are ecologically important because they are needed to maintain important aquatic habitat functions and values for fish and macroinvertebrate communities. This impact would be potentially significant.

This impact would be similar to Impact Aqua-16 (CP1). The impact could be greater under CP3 than under CP1 because the increased reservoir capacity associated with an 18.5-foot raise compared to a 6.5-foot raise would allow for storage of additional water volume (and flows) behind the raised dam.

Sediment transport, deposition, and scour regulate the formation of key habitat features such as point bars, gravel deposits, and SRA habitat. Intermediate to high flows and the associated stage elevation of the river surface also provide a backwater effect on the lowermost segment of tributaries, which reduces the potential for downcutting. These processes are regulated by the magnitude and frequency of flows. Relatively large floods provide the energy required to mobilize sediment from the riverbed, produce meander migration, increase stage elevation, create seasonally inundated floodplains, and inundate floodplain bypasses. Operations under CP3 could result in reduced intermediate to large flows that are necessary for channel forming and maintenance, meander migration, and creation of seasonally inundated floodplains.

Implementation of CP3 would cause a further reduction in the magnitude, duration, and frequency of intermediate to large flows relative to the Existing Condition and No-Action Alternative. Overall, the project would increase the existing, ongoing impacts on geomorphic processes resulting from the operation of Shasta Dam that are necessary for channel forming and maintenance, meander migration, the creation of seasonally inundated floodplains, and the inundation of floodplain bypasses. These effects would likely occur along upper reaches of the lower Sacramento River (mostly upstream from RBPP).

Reductions in the magnitude of high flows would likely be sufficient to reduce ecologically important processes along the upper Sacramento River and its floodplain bypasses. This impact would be potentially significant. Mitigation for this impact is proposed in Section 11.3.4, "Mitigation Measures."

Impact Aqua-17 (CP3): Effects to Delta Fisheries Resulting from Changes to Delta Outflow Based on the results of hydrologic modeling comparing Delta outflow under the No-Action Alternative, Existing Condition, and CP3, CP3 would result in changes to average monthly Delta outflow of less than 5 percent in all year types (with the exception of November of above-normal water years under 2005 and 2030 conditions). This impact on Delta fisheries and hydrologic transport processes within the Bay-Delta would be less than significant.

Results of the comparison of Delta outflows under CP3 compared with the Existing Condition and No-Action Alternative are summarized by month and water year type in Table 11-34. Only in November of above-normal water years (compared to the Existing Condition and No-Action Alternative) would changes in Delta outflow exceed 5 percent. Based on the results of this comparison, CP3 would have a less-than-significant impact on Delta fisheries and hydrologic transport processes within the Bay-Delta as a consequence of changes in Delta outflow under existing conditions. Mitigation for this impact is not needed, and thus not proposed.

Table 11-34. Delta Outflow Under Existing Conditions, No-Action Alternative, and CP3

		Existing Condition	CP3 (2005)		No-Action Alternative	CP3 (2030)	
Month	Water Year	Flow (cfs)	Flow (cfs)	Percent Change	Flow (cfs)	Flow (cfs)	Percent Change
January	Average	42,078	41,783	-1	42,169	41,769	-1
	W	84,136	83,571	-1	84,037	83,211	-1
	AN	47,221	46,936	-1	46,984	46,680	-1
	BN	21,610	21,584	0	21,990	22,027	0
	D	14,166	13,973	-1	14,452	14,168	-2
	C	11,560	11,366	-2	11,757	11,501	-2
February	Average	51,618	51,432	0	51,430	51,126	-1
	W	95,261	94,991	0	94,634	94,196	0
	AN	60,080	59,591	-1	60,278	59,405	-1
	BN	35,892	35,791	0	35,665	35,669	0
	D	20,978	20,909	0	20,946	20,775	-1
	C	12,902	12,924	0	13,088	13,089	0
March	Average	42,722	42,577	0	42,585	42,428	0
	W	78,448	78,457	0	78,376	78,402	0
	AN	53,486	52,493	-2	53,139	52,224	-2
	BN	23,102	22,943	-1	22,980	22,668	-1
	D	19,763	19,864	1	19,559	19,656	0
	C	11,881	11,892	0	11,893	11,900	0
April	Average	30,227	30,300	0	30,743	30,826	0
	W	54,640	54,671	0	55,460	55,482	0
	AN	32,141	32,225	0	32,971	33,053	0
	BN	21,773	21,952	1	22,511	22,645	1
	D	14,347	14,430	1	14,538	14,665	1
	C	9,100	9,115	0	8,873	8,961	1
May	Average	22,619	22,552	0	22,249	22,209	0
	W	41,184	41,155	0	40,543	40,526	0
	AN	24,296	24,171	-1	24,454	24,255	-1
	BN	16,346	15,983	-2	15,989	15,703	-2
	D	10,554	10,655	1	10,116	10,268	2
	C	6,132	6,134	0	5,910	5,975	1
June	Average	12,829	12,779	0	12,660	12,582	-1
	W	23,473	23,473	0	23,015	23,028	0
	AN	12,080	11,666	-3	11,799	11,431	-3
	BN	7,995	8,004	0	7,991	7,865	-2
	D	6,691	6,734	1	6,764	6,737	0
	C	5,361	5,363	0	5,378	5,372	0
July	Average	7,864	7,877	0	7,864	7,863	0
	W	11,230	11,270	0	11,181	11,190	0
	AN	9,562	9,525	0	9,407	9,381	0
	BN	7,117	7,130	0	7,225	7,244	0
	D	5,005	5,005	0	5,052	5,016	-1
	C	4,034	4,054	1	4,098	4,126	1
August	Average	4,322	4,316	0	4,335	4,329	0
	W	5,302	5,307	0	5,097	5,088	0
	AN	4,000	4,000	0	4,000	4,000	0
	BN	4,000	4,000	0	4,002	4,002	0
	D	3,906	3,878	-1	4,142	4,171	1
	C	3,520	3,509	0	3,699	3,631	-2

Table 11-34. Delta Outflow Under Existing Conditions, No-Action Alternative, and CP3 (contd.)

		Existing Condition	CP3 (Existing Condition)		No-Action Alternative	CP3 (Future Condition)	
Month	**Water Year**	**Base Flow (cfs)**	**Flow (cfs)**	**Percent Change**	**Base Flow (cfs)**	**Flow (cfs)**	**Percent Change**
September	Average	9,841	9,836	0	9,844	9,864	0
	W	19,695	19,687	0	19,702	19,712	0
	AN	11,784	11,771	0	11,849	11,836	0
	BN	3,876	3,885	0	3,913	3,945	1
	D	3,508	3,484	-1	3,442	3,491	1
	C	3,008	3,027	1	3,005	3,020	1
October	Average	6,067	6,056	0	6,000	5,981	0
	W	7,926	7,866	-1	7,633	7,539	-1
	AN	5,309	5,368	1	5,476	5,593	2
	BN	5,479	5,502	0	5,502	5,469	-1
	D	5,228	5,247	0	5,236	5,235	0
	C	4,741	4,682	-1	4,714	4,711	0
November	Average	11,706	11,541	-1	11,675	11,484	-2
	W	17,717	17,637	0	17,715	17,534	-1
	AN	12,667	11,728	-7	12,491	11,755	-6
	BN	8,543	8,527	0	8,686	8,591	-1
	D	8,482	8,479	0	8,414	8,384	0
	C	6,250	6,256	0	6,150	6,131	0
December	Average	21,755	21,427	-2	21,745	21,386	-2
	W	44,974	44,189	-2	44,661	43,587	-2
	AN	18,581	18,521	0	18,562	18,180	-2
	BN	12,219	11,752	-4	12,326	12,070	-2
	D	8,531	8,477	-1	8,803	8,933	1
	C	5,580	5,730	-3	5,677	6,040	6

Note:
A negative percentage change reflects a reduction in Delta outflow
Key:
AN = above-normal
BN = below-normal
C = critical
CP = Comprehensive Plan
cfs = cubic feet per second
D = dry
W = wet

Impact Aqua-18 (CP3): Effects to Delta Fisheries Resulting from Changes to Delta Inflow Based on the results of hydrologic modeling comparing Delta inflow under CP3 to the Existing Condition and No-Action Alternative, CP3 would not decrease average monthly Delta inflow by 5 percent or more in any year type. This impact on Delta fisheries and hydrologic transport processes within the Bay-Delta would be less than significant.

Results of the comparison of Delta inflows between the Existing Condition, No-Action Alternative, and CP3 are summarized by month and water year type in Table 11-35. Under CP3, Delta inflow would not decrease by more than 5 percent during any month compared to either the Existing Condition or the No-Action Alternative. Based on the results of this comparison, CP3 would have a less-than-significant effect on Delta fisheries and hydrologic transport processes within the Bay-Delta as a consequence of changes in Delta inflow. Mitigation for this impact is not needed, and thus not proposed.

Table 11-35. Delta Inflow Under Existing Conditions, No-Action Alternative, and CP3

		Existing Condition	CP3 (2005)		No-Action Alternative	CP3 (2030)	
Month		Flow (cfs)	Flow (cfs)	Percent Change	Flow (cfs)	Flow (cfs)	Percent Change
January	Average	47,426	47,165	-1	47,457	47,099	-1
	W	89,431	88,863	-1	89,328	88,512	-1
	AN	51,611	51,258	-1	51,267	51,016	0
	BN	27,269	27,243	0	27,576	27,612	0
	D	20,125	19,963	-1	20,371	20,093	-1
	C	16,699	16,774	0	16,749	16,701	0
February	Average	57,835	57,646	0	57,623	57,342	0
	W	103,140	102,862	0	102,606	102,190	0
	AN	65,379	64,639	-1	65,574	64,664	-1
	BN	41,782	41,823	0	41,374	41,367	0
	D	26,530	26,484	0	26,431	26,290	-1
	C	17,818	17,886	0	17,958	18,065	1
March	Average	49,829	49,701	0	49,713	49,536	0
	W	87,688	87,695	0	87,703	87,713	0
	AN	61,498	60,733	-1	61,339	60,449	-1
	BN	30,569	30,414	-1	30,415	30,086	-1
	D	24,943	24,957	0	24,640	24,645	0
	C	15,933	15,964	0	15,896	15,936	0
April	Average	33,962	34,036	0	34,783	34,868	0
	W	58,684	58,715	0	60,017	60,029	0
	AN	35,588	35,673	0	36,738	36,823	0
	BN	25,351	25,531	1	26,403	26,537	1
	D	17,962	18,048	0	18,315	18,463	1
	C	12,817	12,832	0	12,635	12,726	1
May	Average	27,383	27,315	0	27,091	27,039	0
	W	46,973	46,945	0	46,494	46,477	0
	AN	28,466	28,341	0	28,711	28,514	-1
	BN	20,747	20,384	-2	20,427	20,140	-2
	D	14,882	14,983	1	14,534	14,686	1
	C	10,347	10,341	0	10,038	10,027	0
June	Average	22,171	22,139	0	22,090	22,029	0
	W	35,459	35,459	0	35,172	35,190	0
	AN	23,124	22,703	-2	22,776	22,408	-2
	BN	16,884	17,003	1	16,941	16,932	0
	D	14,095	14,134	0	14,337	14,294	0
	C	10,710	10,710	0	10,694	10,686	0
July	Average	23,099	23,110	0	22,839	22,894	0
	W	27,442	27,477	0	27,496	27,501	0
	AN	25,169	25,070	0	25,065	25,015	0
	BN	23,282	23,400	1	23,362	23,371	0
	D	20,937	20,904	0	20,082	20,195	1
	C	14,647	14,661	0	14,048	14,283	2

Table 11-35. Delta Inflow Under Existing Conditions, No-Action Alternative, and CP3 (contd.)

		Existing Condition	CP3 (2005)		No-Action Alternative	CP3 (2030)	
Month		**Flow (cfs)**	**Flow (cfs)**	**Percent Change**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**
August	Average	17,147	17,132	0	17,026	17,122	1
	W	20,235	20,248	0	20,154	20,146	0
	AN	18,784	18,759	0	18,927	18,941	0
	BN	18,274	18,212	0	18,297	18,332	0
	D	15,066	15,066	0	14,371	14,680	2
	C	10,626	10,593	0	10,850	11,000	1
September	Average	20,946	20,993	0	21,145	21,272	1
	W	31,918	32,081	1	32,428	32,495	0
	AN	23,912	23,913	0	24,747	24,917	1
	BN	16,518	16,542	0	16,563	16,650	1
	D	14,440	14,329	-1	14,233	14,437	1
	C	9,130	9,237	1	8,809	8,957	2
October	Average	14,407	14,469	0	14,175	14,268	1
	W	17,072	17,057	0	16,558	16,562	0
	AN	13,176	13,412	2	13,223	13,433	2
	BN	14,044	14,065	0	14,159	14,188	0
	D	13,133	13,241	1	12,846	13,100	2
	C	12,196	12,234	0	11,976	11,977	0
November	Average	19,512	19,550	0	19,463	19,534	0
	W	26,429	26,571	1	26,536	26,504	0
	AN	20,269	19,609	-3	20,052	19,676	-3
	BN	16,984	17,037	0	16,980	16,947	0
	D	15,771	16,027	2	15,705	16,163	2
	C	12,330	12,494	1	12,081	12,364	0
December	Average	30,984	30,666	-1	30,988	30,568	-1
	W	53,758	52,982	-1	53,516	52,445	-2
	AN	28,431	28,381	0	28,223	27,886	-1
	BN	21,958	21,520	-2	22,143	21,965	-1
	D	18,560	18,516	0	18,837	18,715	-1
	C	13,363	13,498	1	13,484	13,666	1

Note:
A negative percentage change reflects a reduction in Delta inflow
Key:
AN = above-normal
BN = below-normal
C = critical
cfs = cubic feet per second
CP = Comprehensive Plan
D = dry
W = wet

Impact Aqua-19 (CP3): Effects to Delta Fisheries Resulting from Changes in Sacramento River Inflow CP3 operation would result in a variable response in Sacramento River inflow, resulting in both increases and decreases in river flow above basis-of-comparison conditions depending on month and water year type. Decreases in Sacramento River inflow would not equal or exceed 5 percent. This impact would be less than significant.

Results of hydrologic modeling, by month and year type, for the Existing Condition, No-Action Alternative, and CP3 for Sacramento River inflow are presented in Table 11-36. Results of these analyses show a variable response in Sacramento River inflow with CP3 operations resulting in both increases and decreases in river inflow above the Existing Condition and the No-Action Alternative, depending on month and water year. Under CP3, Sacramento River inflow would not decrease by 5 percent or more. Based on these results, the impact of CP3 on fish habitat and transport mechanisms within the lower Sacramento River and Delta would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 11-36. Sacramento River Inflow Under Existing Conditions, No-Action Alternative, and CP3

		Existing Condition	CP3 (2005)		No-Action Alternative	CP3 (2030)	
Month	**Water Year**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**
January	Average	31,139	31,068	0	31,167	31,061	0
	W	50,173	50,005	0	50,164	49,930	0
	AN	38,122	38,012	0	38,006	37,955	0
	BN	22,370	22,422	0	22,540	22,658	1
	D	16,980	16,885	-1	17,109	16,936	-1
	C	14,384	14,459	1	14,322	14,274	0
February	Average	36,608	36,578	0	36,618	36,535	0
	W	56,740	56,783	0	56,637	56,660	0
	AN	44,453	43,988	-1	44,672	44,089	-1
	BN	30,911	31,056	0	30,780	30,838	0
	D	21,249	21,203	0	21,237	21,095	-1
	C	14,830	14,897	0	15,075	15,179	1
March	Average	32,396	32,342	0	32,352	32,262	0
	W	49,248	49,279	0	49,403	49,448	0
	AN	44,060	43,726	-1	43,972	43,573	-1
	BN	23,188	23,053	-1	23,068	22,758	-1
	D	20,390	20,405	0	20,138	20,143	0
	C	12,971	13,002	0	12,942	12,982	0
April	Average	23,232	23,280	0	23,206	23,292	0
	W	37,918	37,951	0	38,019	38,035	0
	AN	26,053	25,963	0	26,039	26,128	0
	BN	17,518	17,697	1	17,439	17,573	1
	D	13,205	13,290	1	13,164	13,313	1
	C	10,295	10,309	0	10,067	10,158	1

Table 11-36. Sacramento River Inflow Under Existing Conditions, No-Action Alternative, and CP3 (contd.)

		Existing Condition	CP3 (2005)		No-Action Alternative	CP3 (2030)	
Month	**Water Year**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**
May	Average	19,417	19,352	0	19,114	19,064	0
	W	32,095	32,075	0	31,800	31,790	0
	AN	21,204	21,080	-1	21,080	20,882	-1
	BN	14,530	14,168	-2	14,144	13,858	-2
	D	11,226	11,327	1	10,836	10,987	1
	C	8,148	8,142	0	7,874	7,863	0
June	Average	16,508	16,475	0	16,511	16,449	0
	W	24,092	24,092	0	23,905	23,920	0
	AN	16,598	16,176	-3	16,533	16,165	-2
	BN	13,792	13,911	1	13,822	13,812	0
	D	12,283	12,323	0	12,569	12,525	0
	C	9,492	9,491	0	9,516	9,507	0
July	Average	19,518	19,529	0	19,266	19,320	0
	W	20,071	20,104	0	20,058	20,063	0
	AN	22,070	21,970	0	21,976	21,924	0
	BN	21,232	21,349	1	21,374	21,383	0
	D	19,577	19,544	0	18,788	18,900	1
	C	13,683	13,695	0	13,100	13,334	2
August	Average	14,710	14,695	0	14,596	14,690	1
	W	16,285	16,297	0	16,189	16,180	0
	AN	16,418	16,393	0	16,561	16,575	0
	BN	16,112	16,050	0	16,170	16,205	0
	D	13,632	13,632	0	12,968	13,276	2
	C	9,570	9,536	0	9,785	9,933	2
September	Average	18,211	18,257	0	18,417	18,544	1
	W	27,839	28,002	1	28,337	28,403	0
	AN	21,244	21,244	0	22,088	22,257	1
	BN	14,088	14,112	0	14,147	14,233	1
	D	12,522	12,404	-1	12,341	12,545	2
	C	7,664	7,771	1	7,347	7,494	2
October	Average	11,309	11,416	1	11,117	11,219	1
	W	13,419	13,543	1	13,040	13,070	0
	AN	10,499	10,734	2	10,571	10,781	2
	BN	11,053	11,074	0	11,195	11,228	0
	D	10,150	10,258	1	9,830	10,085	3
	C	9,587	9,626	0	9,333	9,334	0

Table 11-36. Sacramento River Inflow Under Existing Conditions, No-Action Alternative, and CP3 (contd.)

		Existing Condition	CP3 (2005)		No-Action Alternative	CP3 (2030)	
Month	**Water Year**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**
November	Average	15,640	15,703	0	15,605	15,724	1
	W	20,726	20,936	1	20,832	20,929	0
	AN	16,893	16,259	-4	16,666	16,344	-2
	BN	13,755	13,809	0	13,793	13,759	0
	D	12,720	12,975	2	12,723	13,181	4
	C	9,948	10,113	2	9,653	9,935	3
December	Average	23,248	23,156	0	23,229	23,096	-1
	W	37,645	37,341	-1	37,434	37,045	-1
	AN	22,604	22,634	0	22,461	22,287	-1
	BN	16,930	16,871	0	17,103	17,196	1
	D	15,760	15,716	0	15,934	15,811	-1
	C	11,303	11,439	1	11,310	11,492	-2

Note:
A negative percentage change reflects a reduction in Sacramento River inflow
Key:
AN = above-normal
BN = below-normal
C = critical
cfs = cubic feet per second
CP = Comprehensive Plan
D = dry
W = wet

Impact Aqua-20 (CP3): Effects to Delta Fisheries Resulting from Changes in San Joaquin River Flow at Vernalis CP3 operation would result in no discernible change in San Joaquin River flows at Vernalis, and therefore no effects on fish habitat or transport mechanisms within the lower San Joaquin River and Delta compared with the Existing Condition and No-Action Alternative. There would be no impact.

Results of hydrologic modeling, by month and water year type, for the Existing Condition, No-Action Alternative, and CP3 for San Joaquin River flow are summarized in Table 11-37. Results of these analyses show that CP3 would have no effect on seasonal San Joaquin River flows compared with the Existing Condition and No-Action Alternative. Based on these results CP3 would have no impact on Delta fisheries or transport mechanisms within the lower San Joaquin River and Delta. Mitigation for this impact is not needed, and thus not proposed.

Table 11-37. San Joaquin River Flow at Vernalis Under Existing Conditions, and CP3

		Existing Condition	CP3 (2005)		No-Action Alternative	CP3 (2030)	
Month	**Water Year**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**
January	Average	4,770	4,770	0	4,764	4,764	0
	W	9,273	9,273	0	9,097	9,097	0
	AN	4,223	4,223	0	4,259	4,259	0
	BN	2,986	2,986	0	3,081	3,081	0
	D	2,084	2,084	0	2,160	2,160	0
	C	1,673	1,673	0	1,746	1,746	0
February	Average	6,265	6,265	0	6,143	6,143	0
	W	11,036	11,036	0	10,845	10,845	0
	AN	6,047	6,047	0	6,179	6,179	0
	BN	5,767	5,767	0	5,565	5,565	0
	D	2,642	2,642	0	2,528	2,528	0
	C	2,161	2,161	0	2,014	2,014	0
March	Average	7,133	7,133	0	7,003	7,003	0
	W	13,443	13,443	0	13,170	13,170	0
	AN	6,788	6,788	0	6,674	6,673	0
	BN	5,322	5,322	0	5,293	5,293	0
	D	2,963	2,963	0	2,895	2,895	0
	C	2,176	2,176	0	2,129	2,129	0
April	Average	6,720	6,720	0	7,533	7,533	0
	W	11,420	11,420	0	12,614	12,614	0
	AN	6,671	6,671	0	7,799	7,798	0
	BN	5,852	5,852	0	6,910	6,910	0
	D	3,726	3,726	0	4,112	4,112	0
	C	2,087	2,087	0	2,118	2,118	0
May	Average	6,204	6,204	0	6,234	6,234	0
	W	11,268	11,268	0	11,135	11,135	0
	AN	5,611	5,611	0	5,987	5,987	0
	BN	5,010	5,010	0	5,108	5,108	0
	D	3,070	3,070	0	3,111	3,111	0
	C	1,920	1,920	0	1,862	1,862	0
June	Average	4,739	4,739	0	4,671	4,671	0
	W	9,451	9,451	0	9,390	9,390	0
	AN	5,608	5,609	0	5,326	5,326	0
	BN	2,424	2,424	0	2,471	2,470	0
	D	1,598	1,598	0	1,554	1,554	0
	C	1,076	1,076	0	1,035	1,035	0
July	Average	3,202	3,202	0	3,208	3,208	0
	W	6,556	6,556	0	6,660	6,660	0
	AN	2,783	2,784	0	2,767	2,768	0
	BN	1,775	1,775	0	1,733	1,733	0
	D	1,282	1,282	0	1,216	1,216	0
	C	898	898	0	880	880	0

Table 11-37. San Joaquin River Flow at Vernalis Under Existing Conditions, and CP3 (contd.)

		Existing Condition	CP3 (2005)		No-Action Alternative	CP3 (2030)	
Month	**Water Year**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**
August	Average	2,029	2,029	0	2,040	2,041	0
	W	3,099	3,099	0	3,158	3,159	0
	AN	2,020	2,020	0	2,014	2,015	0
	BN	1,828	1,828	0	1,817	1,816	0
	D	1,342	1,342	0	1,315	1,315	0
	C	984	984	0	993	993	0
September	Average	2,331	2,331	0	2,340	2,340	0
	W	3,274	3,274	0	3,317	3,317	0
	AN	2,328	2,328	0	2,312	2,312	0
	BN	2,109	2,109	0	2,119	2,119	0
	D	1,795	1,795	0	1,774	1,775	0
	C	1,358	1,358	0	1,355	1,355	0
October	Average	2,757	2,757	0	2,753	2,753	0
	W	3,112	3,112	0	3,107	3,107	0
	AN	2,446	2,446	0	2,424	2,424	0
	BN	2,749	2,749	0	2,718	2,718	0
	D	2,686	2,686	0	2,710	2,710	0
	C	2,416	2,416	0	2,423	2,423	0
November	Average	2,633	2,633	0	2,603	2,603	0
	W	3,372	3,372	0	3,340	3,340	0
	AN	2,213	2,213	0	2,176	2,176	0
	BN	2,412	2,412	0	2,360	2,360	0
	D	2,388	2,388	0	2,355	2,355	0
	C	2,075	2,075	0	2,088	2,088	0
December	Average	3,199	3,199	0	3,263	3,263	0
	W	5,081	5,081	0	5,178	5,178	0
	AN	2,916	2,916	0	2,899	2,899	0
	BN	2,705	2,705	0	2,753	2,753	0
	D	2,047	2,047	0	2,123	2,123	0
	C	1,710	1,710	0	1,785	1,785	0

Note:
A negative percentage change reflects a reduction in San Joaquin River flow
Key:
AN = above-normal
BN = below-normal
C = critical
cfs = cubic feet per second
CP = Comprehensive Plan
D = dry
W = wet

Impact Aqua-21 (CP3): Reduction in Low-Salinity Habitat Conditions Resulting from an Upstream Shift in X2 Location CP3 operation would result in less than 0.5 km movement upstream or downstream from the X2 location from its location under the Existing Condition or No-Action Alternative during February through May and September through November, and thus cause minimal reduction in low-salinity habitats. This impact would be less than significant.

The 1 km X2 criterion was applied to a comparison of hydrologic model results for the Existing Condition, No-Action Alternative, and CP3, by month and water year type, for the months from February through May and September through November. Results of the comparisons are summarized in Table 11-38. These results showed that changes in X2 location under CP3 were less than 1 km (all were less than 0.2 km) with both variable upstream and downstream movement of the X2 location depending on month and water year type. These results are consistent with model results for Delta outflow that showed a less-than-significant change in flows. Based on these results, CP3 would have a less-than-significant impact on low-salinity habitat conditions within the Bay-Delta. Mitigation for this impact is not needed, and thus not proposed.

Table 11-38. Difference in X2 Under Existing Conditions, No-Action Alternative, and CP3

		Existing Condition	CP3 (2005)		No-Action Alternative	CP3 (2030)	
Month	**Water Year**	**Location (km)**	**Location (km)**	**Difference (km)**	**Location (km)**	**Location (km)**	**Difference (km)**
January	Average	67.5	67.5	0.0	67.3	67.2	0.0
	W	53.6	53.7	0.1	53.7	53.7	0.1
	AN	61.7	61.7	0.0	61.6	61.6	0.0
	BN	72.1	72.0	-0.1	71.7	71.6	-0.1
	D	77.9	78.0	0.1	77.4	77.4	-0.1
	C	82.2	82.2	0.1	81.9	81.9	0.0
February	Average	60.9	61.0	0.0	60.8	60.9	0.0
	W	50.4	50.4	0.0	50.4	50.4	0.0
	AN	54.8	54.8	0.0	54.6	54.6	0.1
	BN	61.0	61.0	0.0	60.9	60.9	0.0
	D	70.1	70.1	0.0	69.9	69.9	0.0
	C	76.2	76.3	0.1	75.9	76.1	0.2
March	Average	60.9	60.9	0.0	60.9	61.0	0.0
	W	52.1	52.1	0.0	52.1	52.1	0.0
	AN	53.6	53.7	0.1	53.7	53.7	0.1
	BN	63.3	63.3	0.1	63.3	63.5	0.2
	D	67.1	67.0	-0.1	67.2	67.1	0.0
	C	75.2	75.2	0.0	75.1	75.1	0.1

Table 11-38. Difference in X2 Under Existing Conditions, No-Action Alternative, and CP3 (contd.)

		Existing Condition	CP3 (2005)		No-Action Alternative	CP3 (2030)	
Month	**Water Year**	**Location (km)**	**Location (km)**	**Difference (km)**	**Location (km)**	**Location (km)**	**Difference (km)**
April	Average	63.5	63.5	0.0	63.4	63.3	0.0
	W	54.5	54.5	0.0	54.3	54.3	0.0
	AN	58.6	58.6	0.0	58.4	58.4	0.0
	BN	64.5	64.4	-0.1	64.1	64.1	0.0
	D	69.9	69.8	-0.1	69.9	69.7	-0.1
	C	77.5	77.5	0.0	77.6	77.6	0.0
May	Average	67.5	67.5	0.0	67.7	67.6	-0.1
	W	57.6	57.6	0.0	57.7	57.7	0.0
	AN	62.7	62.7	0.0	62.6	62.6	0.0
	BN	68.3	68.3	0.1	68.3	68.4	0.0
	D	74.4	74.2	-0.2	74.8	74.6	-0.2
	C	82.5	82.5	0.0	82.9	82.7	-0.1
June	Average	74.5	74.5	0.0	74.7	74.7	0.0
	W	65.0	65.0	0.0	65.2	65.2	0.0
	AN	72.6	72.8	0.2	72.7	72.9	0.2
	BN	76.6	76.6	0.0	76.7	76.8	0.1
	D	80.4	80.3	-0.1	80.7	80.6	-0.1
	C	85.9	85.9	0.0	86.0	86.0	-0.1
July	Average	80.5	80.5	0.0	80.5	80.5	0.0
	W	74.4	74.4	0.0	74.5	74.5	0.0
	AN	78.1	78.3	0.2	78.4	78.5	0.2
	BN	81.7	81.7	0.0	81.6	81.7	0.0
	D	84.8	84.8	-0.1	84.8	84.8	0.0
	C	88.1	88.1	0.0	88.0	88.0	0.0
August	Average	85.6	85.6	0.0	85.6	85.5	0.0
	W	82.7	82.6	0.0	82.8	82.8	0.0
	AN	83.7	83.8	0.0	83.9	83.9	0.0
	BN	85.6	85.5	0.0	85.5	85.4	0.0
	D	87.8	87.8	0.0	87.5	87.5	0.0
	C	90.4	90.4	0.0	90.2	90.3	0.0
September	Average	83.7	83.7	0.0	83.7	83.6	0.0
	W	73.4	73.4	0.0	73.5	73.5	0.0
	AN	81.4	81.4	0.0	81.4	81.4	0.0
	BN	88.8	88.8	0.0	88.8	88.8	0.0
	D	90.2	90.2	0.0	90.0	90.0	-0.1
	C	92.5	92.5	0.0	92.3	92.3	0.0

Table 11-38. Difference in X2 Under Existing Conditions, No-Action Alternative, and CP3 (contd.)

		Existing Condition	CP3 (2005)		No-Action Alternative	CP3 (2030)	
Month	**Water Year**	**Location (km)**	**Location (km)**	**Difference (km)**	**Location (km)**	**Location (km)**	**Difference (km)**
October	Average	83.9	83.9	0.0	83.9	83.9	0.0
	W	73.6	73.5	0.0	73.7	73.7	0.0
	AN	79.8	79.8	0.0	79.8	79.8	0.0
	BN	88.9	88.9	0.0	88.9	88.9	0.0
	D	91.4	91.4	0.0	91.3	91.3	0.0
	C	93.3	93.2	0.0	93.1	93.0	-0.1
November	Average	82.2	82.3	0.1	82.2	82.3	0.1
	W	73.1	73.1	0.0	73.2	73.2	0.0
	AN	78.4	78.4	0.0	78.4	78.5	0.1
	BN	84.8	85.4	0.6	84.8	85.3	0.6
	D	88.9	88.9	0.0	88.8	88.9	0.1
	C	92.6	92.7	0.0	92.8	92.7	-0.1
December	Average	76.1	76.2	0.1	76.0	76.0	0.0
	W	62.9	63.1	0.1	63.0	63.2	0.1
	AN	76.4	76.8	0.4	76.4	76.8	0.4
	BN	81.4	81.4	0.0	81.1	81.1	0.0
	D	82.8	82.9	0.1	82.6	82.4	-0.1
	C	87.9	87.7	-0.2	87.8	87.5	-0.4

Key:
AN = above-normal
BN = below-normal
C = critical
CP = Comprehensive Plan
D = dry
km = kilometer
W = wet

Impact Aqua-22 (CP3): Increase in Mortality of Species of Primary Management Concern as a Result of Increased Reverse Flows in Old and Middle Rivers CP3 operation would result in minimal changes to reverse flows in Old and Middle rivers during January, March and April; however, flows do not exceed (become more negative) -5,000 cfs. Because the flows do not exceed -5,000 cfs, the increases in reverse flows are not expected to contribute to an increase in the vulnerability of delta smelt, longfin smelt, Chinook salmon, juvenile striped bass, or threadfin shad, but summer Old and Middle river flows could contribute to an increase in vulnerability of other resident warm-water fish to increased salvage and potential losses. This impact would be less than significant.

Results of the analysis showed several occurrences when reverse flows within Old and Middle rivers would be higher than under the Existing Condition or No-Action Alternative by more than 5 percent. These events would occur in critical, dry, and above-normal water years, which would be expected as a result of greater export operations under CP3.

During January (Table 11-39), operations under CP3 would result in an increase in reverse flow of greater than 5 percent during critical years compared with both Existing Conditions and the No-Action Alternative. Based on results of the delta smelt analysis of the relationship between reverse flows and delta smelt salvage, the increase of approximately 200 cfs in a critical water year would not be expected to result in a significant increase in adverse effects to delta smelt because their presence in the region is minimal during this time. Longfin smelt, however, are likely in the area during dry water years, but the flows do not exceed -5,000 cfs, so longfin smelt are not expected to experience significant impacts.

Table 11-39. Old and Middle River Reverse Flows Under Existing Conditions, No-Action Alternative, and CP3

		Existing Condition	CP3 (2005)		No-Action Alternative	CP3 (2030)	
Month	**Water Year**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**
January	Average	-3,542	-3,575	1	-3,553	-3,592	1
	W	-2,034	-2,034	0	-2,151	-2,161	0
	AN	-3,654	-3,592	-2	-3,574	-3,626	1
	BN	-4,240	-4,240	0	-4,240	-4,240	0
	D	-4,773	-4,802	1	-4,772	-4,777	0
	C	-4,033	-4,282	6	-3,940	-4,129	5
February	Average	-3,293	-3,287	0	-3,358	-3,375	1
	W	-2,745	-2,734	0	-2,950	-2,972	1
	AN	-3,248	-3,012	-7	-3,165	-3,129	-1
	BN	-3,335	-3,464	4	-3,291	-3,279	0
	D	-4,016	-4,033	0	-4,045	-4,063	0
	C	-3,391	-3,433	1	-3,482	-3,576	3
March	Average	-2,784	-2,799	1	-2,877	-2,860	-1
	W	-1,792	-1,789	0	-2,023	-2,010	-1
	AN	-4,021	-4,230	5	-4,260	-4,282	1
	BN	-4,005	-4,008	0	-3,982	-3,972	0
	D	-2,951	-2,872	-3	-2,918	-2,834	-3
	C	-2,023	-2,038	1	-1,994	-2,022	1
April	Average	955	955	0	1,060	1,059	0
	W	2,706	2,706	0	2,798	2,806	0
	AN	1,087	1,087	0	1,314	1,314	0
	BN	697	697	0	898	898	0
	D	-244	-242	-1	-207	-220	6
	C	-874	-874	0	-872	-872	0

Table 11-39. Old and Middle River Reverse Flows Under Existing Conditions, No-Action Alternative, and CP3 (contd.)

		Existing Condition	CP3 (2005)		No-Action Alternative	CP3 (2030)	
Month	**Water Year**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**
May	Average	491	492	0	416	426	2
	W	2,077	2,076	0	1,781	1,781	0
	AN	562	562	0	646	646	0
	BN	277	277	0	270	271	0
	D	-674	-674	0	-696	-695	0
	C	-1,018	-1,012	-1	-936	-867	-7
June	Average	-3,654	-3,669	0	-3,718	-3,735	0
	W	-4,226	-4,226	0	-4,354	-4,359	0
	AN	-4,825	-4,819	0	-4,818	-4,818	0
	BN	-4,137	-4,233	2	-4,119	-4,227	3
	D	-3,079	-3,079	0	-3,205	-3,191	0
	C	-1,542	-1,542	0	-1,542	-1,542	0
July	Average	-9,502	-9,500	0	-9,292	-9,330	0
	W	-8,948	-8,942	0	-8,905	-8,901	0
	AN	-9,993	-9,935	-1	-9,929	-9,906	0
	BN	-10,886	-10,982	1	-10,903	-10,908	0
	D	-10,998	-10,969	0	-10,419	-10,480	1
	C	-6,355	-6,343	0	-5,928	-6,121	3

Note:
A positive percentage change reflects more negative reverse flows under CP3 when compared to the Existing Condition or the No-Action Alternative.
Key:
AN = above-normal
BN = below-normal
C = critical
cfs = cubic feet per second
CP = Comprehensive Plan
D = dry
W = wet

Juvenile Chinook salmon and steelhead are migrating through the Delta during January, and an increase in average monthly reverse flows of around 200 cfs would be expected to increase the potential risk of increased mortality to these species. However, given the tidal volumes and hydrodynamics of the Old and Middle rivers region, it is not expected that the change in reverse flows in January in a critical year would result in a detectable change in fish survival. The majority of juvenile Chinook salmon emigrating from the San Joaquin River typically migrate downstream later in dry years and would not be expected to occur in high numbers within Old and Middle rivers in January.

The increase in reverse flows estimated to occur under CP3 in above-normal water years in March (under 2005 conditions) and in dry water years in April (under 2030 conditions) would exceed 5 percent. Juvenile and larval delta smelt occur in the area in March and April. A change in Old and Middle river flows of approximately 100 to 200 cfs does not increase the flows to beyond -5,000 cfs.

The potential increase in losses during January, March and April under CP3 is considered to be less than significant. Mitigation for this impact is not proposed because operations will be guided by RPAs established by NMFS and USFWS BOs to reduce any impacts to listed fish species, which would thus reduce impacts to non-listed species as well.

Impact Aqua-23 (CP3): Increase in the Risk of Entrainment or Salvage of Species of Primary Management Concern at CVP and SWP Export Facilities Due to Changes in CVP and SWP Exports CP3 operations may result in an increase in CVP and SWP exports, which is assumed to result in a direct proportional increase in the risk of fish being entrained and salvaged at the facilities. Future operations of the SWP and CVP export facilities would continue to be managed and regulated in accordance with incidental take limits established for each of the protected fish by USFWS, NMFS, and CDFW. The resulting impact to Chinook salmon would be less than significant; the resulting impact to delta smelt, longfin smelt, steelhead, striped bass, and splittail would be potentially significant. Overall, this impact would be potentially significant.

Results of entrainment loss modeling at the CVP and SWP export facilities are presented in Table 11-40 for CP3. The total numbers of fish lost annually, by species, are presented in Attachment 1 of the *Fisheries and Aquatic Ecosystems Technical Report.* The difference between the nonoperations-related and operations-related fish mortality is represented as the entrainment index, shown in Table 11-40, to represent the effect of project operations on each fish species at the CVP and SWP facilities.

Table 11-40. Indices of Entrainment at the CVP and SWP Facilities Comparing Existing Conditions, No-Action Alternative, and CP3

Species	Water Year	CP3 minus Existing Condition	Percent Change	CP3 Minus Future Condition	Percent Change
Delta Smelt	Average	42	0.1	-49	-0.1
	W	-4	-0.0	20	0.0
	AN	-60	-0.1	12	0.0
	BN	305	0.9	292	0.8
	D	-6	-0.0	-43	-0.1
	C	10	0.0	-665	-2.9
Chinook Salmon	Average	53	0.1	-37	-0.1
	W	-16	-0.0	8	0.0
	AN	-123	-0.2	33	0.1
	BN	302	0.6	116	0.2
	D	-47	-0.1	-52	-0.1
	C	235	0.7	-360	-1.1
Longfin Smelt	Average	-2	-0.0	-29	-0.4
	W	0	-0.0	-4	-0.0
	AN	1	0.0	1	0.0
	BN	3	0.1	4	0.1
	D	-2	-0.0	5	0.1
	C	-17	-0.3	-202	-4.0

Table 11-40. Indices of Entrainment at the CVP and SWP Facilities Comparing Existing Conditions, No-Action Alternative, and CP3 (contd.)

Species	Water Year	CP3 minus Existing Condition	Percent Change	CP3 Minus Future Condition	Percent Change
Steelhead	Average	7	0.2	8	0.2
	W	-3	-0.1	4	0.1
	AN	-31	-0.7	4	0.1
	BN	36	0.9	-3	-0.1
	D	-5	-0.2	-10	-0.3
	C	55	2.0	57	2.1
Striped Bass	Average	3,981	0.3	7,305	0.6
	W	2,316	0.1	2,465	0.1
	AN	-513	-0.0	3,333	0.2
	BN	15,204	1.1	12,919	1.0
	D	1,563	0.1	8,672	0.8
	C	2,616	0.4	13,162	2.2
Splittail	Average	507	0.2	886	0.3
	W	-36	-0.0	158	0.0
	AN	-738	-0.2	-171	-0.1
	BN	4,107	1.6	3,650	1.4
	D	-283	-0.1	164	0.1
	C	-83	-0.1	1,378	1.4

Note: A negative percentage change reflects a reduction in entrainment risk while a positive percentage change reflects an increase in entrainment risk.

Key:
AN = above-normal
BN = below-normal
C = critical
cfs = cubic feet per second
CP = Comprehensive Plan
CVP = Central Valley Project
D = dry
SWP = State Water Project
W = wet

Results of entrainment risk calculations for delta smelt showed a change of less than 1 percent in wet, above-normal, and below-normal water years and an increase in risk of less than 3 percent during critical water years under CP3 relative to the Existing Condition (Table 11-40). The risk of increased losses of delta smelt under CP3 compared to the No-Action Alternative (Table 11-40) would be greatest in the below-normal water years. Although the incremental change in the risk of delta smelt losses resulting from CVP and SWP export operations is small, delta smelt population abundance is currently at such critically low levels that even a small increase in the risk of losses is considered to be potentially significant. The increase in risk is also expected to contribute to cumulative factors affecting the survival of delta smelt.

The estimated change in the risk of losses for Chinook salmon increases during below-normal and critical water years under 2005 conditions, and above-normal and below-normal water years under 2030 conditions (Table 11-40). Given the numbers of juvenile Sacramento River Chinook salmon produced each year in the Central Valley, the relatively small incremental increase in the risk of entrainment/salvage at the CVP and SWP export facilities would be a less-than-significant direct impact but would contribute incrementally to the overall cumulative factors affecting juvenile Chinook salmon survival within the Delta, and population dynamics of the stocks.

The estimated change in the risk of longfin smelt entrainment/salvage under CP3 compared to the Existing Condition and the No-Action Alternative shows small positive and negative changes depending on water year type and alternative (Table 11-40). These small changes in the risk of entrainment are considered to be less than significant.

The estimated change in the risk to steelhead of entrainment/salvage at the CVP and SWP export facilities are summarized in Table 11-40. The small positive and negative changes in risk under wet, above-normal, below-normal, and dry water years are considered to be less than significant. The increase (approximately 2 percent) in risk of steelhead losses in critical water years are considered to be potentially significant based on the apparently low abundance of juvenile Sacramento and San Joaquin river steelhead migrating through the Delta, but would contribute directly to cumulative factors affecting the survival and population dynamics of Central Valley steelhead. The predicted increase in potential entrainment risk for steelhead under critical water years represents an initial estimate of the change (percentage) between CP3 and Existing Conditions and the No-Action Alternative, and does not allow the predicted losses to be evaluated at the population level (see Attachment 1 of the *Fisheries and Aquatic Ecosystems Technical Report).*

The change in risk to juvenile striped bass for entrainment/salvage at the CVP and SWP export facilities are summarized in Table 11-40. The change in risk in wet, above-normal, and below-normal water years are considered to be less than significant based on the abundance of striped bass, but would contribute to the cumulative factors affecting striped bass survival and population dynamics in the Delta. The losses of juvenile striped bass increased substantially under dry and critical water years, which would be expected with an increase in exports during the summer months and is considered to be potentially significant. The increased losses under CP3, particularly in drier water years when juvenile striped bass production is lower, would be expected to contribute to the cumulative effects of factors affecting juvenile striped bass survival in the Delta.

The increased risk index for splittail was less than 1 percent under both the Existing Condition and No-Action Alternative, and was considered to be less than significant. The loss index increased during dry and critical water years, with the greatest increase for CP3. Higher risk of entrainment/salvage losses in drier water years has a potentially greater effect of abundance of juvenile splittail since reproductive success and overall juvenile abundance is typically lower within the Delta in dry years. The increased risk of losses in drier years was considered to be potentially significant. The increased losses would also contribute to cumulative factors affecting survival of juvenile splittail within the Delta.

Impact Aqua-23 (CP3) is considered to be less than significant for Chinook salmon, and longfin smelt, but potentially significant for delta smelt, steelhead, striped bass, and splittail. Mitigation for this impact is not proposed because operations will be guided by RPAs established by NMFS and USFWS BOs to reduce any impacts to listed fish species, and thus, reduce impacts to non-listed fishes as well.

CVP/SWP Service Areas

Impact Aqua-24 (CP3): Impacts on Aquatic Habitats and Fish Populations in the CVP and SWP Service Areas Resulting from Modifications to Existing Flow Regimes   Project implementation would result in modified flow regimes that would reduce the frequency and magnitude of high winter flows along the Sacramento River; however, the hydrologic effects to tributaries and reservoirs (e.g., New Melones and San Luis) with CVP and SWP dams, as well as the conveyances south of the Delta would be substantially less than impacts on the lower Sacramento River. The change in hydrology in the CVP and SWP service areas could affect aquatic habitats that provide habitat for the fish community; however, these changes would not result in substantial effects on their distribution or abundance. Therefore, this impact would be less than significant.

This impact would be similar to Impact Aqua-24 (CP1). The hydrologic effects to the CVP and SWP service areas would not result in substantial effects on the distribution or abundance of the fish species in the CVP and SWP service areas. The effects from CP3 on CVP and SWP reservoir elevations, filling, spilling, and planned releases, and resulting flows downstream from those reservoirs, would be small and well within the range of variability that commonly occurs in these reservoirs and downstream. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CP4 and CP4A – 18.5-Foot Dam Raise, Anadromous Fish Focus with Water Supply Reliability

CP4 and CP4A focus on increasing anadromous fish survival while also increasing water supply reliability. By raising Shasta Dam 18.5 feet, in combination with spillway modifications, CP4 and CP4A would increase the height of the reservoir full pool by 20.5 feet and enlarge the total storage capacity in the reservoir by 634,000 acre-feet. The existing TCD would also be extended to achieve efficient use of the expanded cold-water pool. The additional storage created by the 18.5-foot dam raise would be used to improve the ability to meet temperature objectives and habitat requirements for anadromous fish during drought years and increase water supply reliability. CP4A is identical to CP4 except for the operations of Shasta Dam and reservoir. Both alternatives have similar reservoir operations in that they each dedicate a portion of the new storage in Shasta Lake for Sacramento River anadromous fish purposes (e.g., cold water pool); however, the portion of this dedicated storage varies.

For CP4, about 378,000 acre-feet of the increased reservoir storage space would be dedicated to increasing the supply of cold water for anadromous fish survival. Operations for the remaining portion of increased storage for CP4A (approximately 256,000 acre-feet) would be the same as in CP1, with 70,000 acre-feet reserved in dry years and 35,000 acre-feet reserved in critical years to specifically focus on increasing M&I deliveries.

For CP4A, about 191,000 acre-feet of the increased reservoir storage space would be dedicated to increasing the supply of cold water for anadromous fish survival. Operations for the remaining portion of increased storage for CP4A (approximately 443,000 acre-feet) would be the same as in CP2, with 120,000 acre-feet reserved in dry years and 60,000 acre-feet reserved in critical years to specifically focus on increasing M&I deliveries.

CP4 and CP4A both include an adaptive management plan for the cold-water pool, and augmenting spawning gravel and restoring riparian, floodplain, and side channel habitat at one or more sites in the upper Sacramento River.

Shasta Lake and Vicinity This section describes impacts on the Shasta Lake and vicinity portion of the primary study area for CP4 and CP4A.

Impact Aqua-1 (CP4 or CP4A): Effects on Nearshore, Warm-Water Habitat in Shasta Lake from Project Operations Under CP4 or CP4A, project operations would contribute to an increase in the surface area and WSEL of Shasta Lake, which would in turn increase the area and productivity of nearshore, warm-water habitat. CP4 or CP4A operations would also result in reduced monthly fluctuations in WSEL, which would contribute to increased reproductive success, young-of-the-year production, and the juvenile growth rate of warm-water fish species. Similar to CP3, the value of existing structural habitat improvements would be diminished to varying degrees; however, the existing habitat enhancement features would become functional during reservoir drawdowns later in the season and during below-normal and drier years, when the reservoir does not refill. Additionally, environmental commitments during construction include using brush and trees cleared for other project purposes to extend and enhance existing fish habitat structures into the new inundated varial zone. Large areas of the shoreline would not be cleared, and the vegetation along these sections will be inundated periodically, providing additional structural fish habitat. In the short term, this newly inundated vegetation will initially increase warm-water fish habitat, with decay expected to occur over several decades. This impact would be less than significant for alternatives CP4 and CP4A.

This impact would be similar to Impacts Aqua-1 (CP1, CP2, and CP3), but the surface area would be larger under the 18.5-foot dam raise than under CP1 and

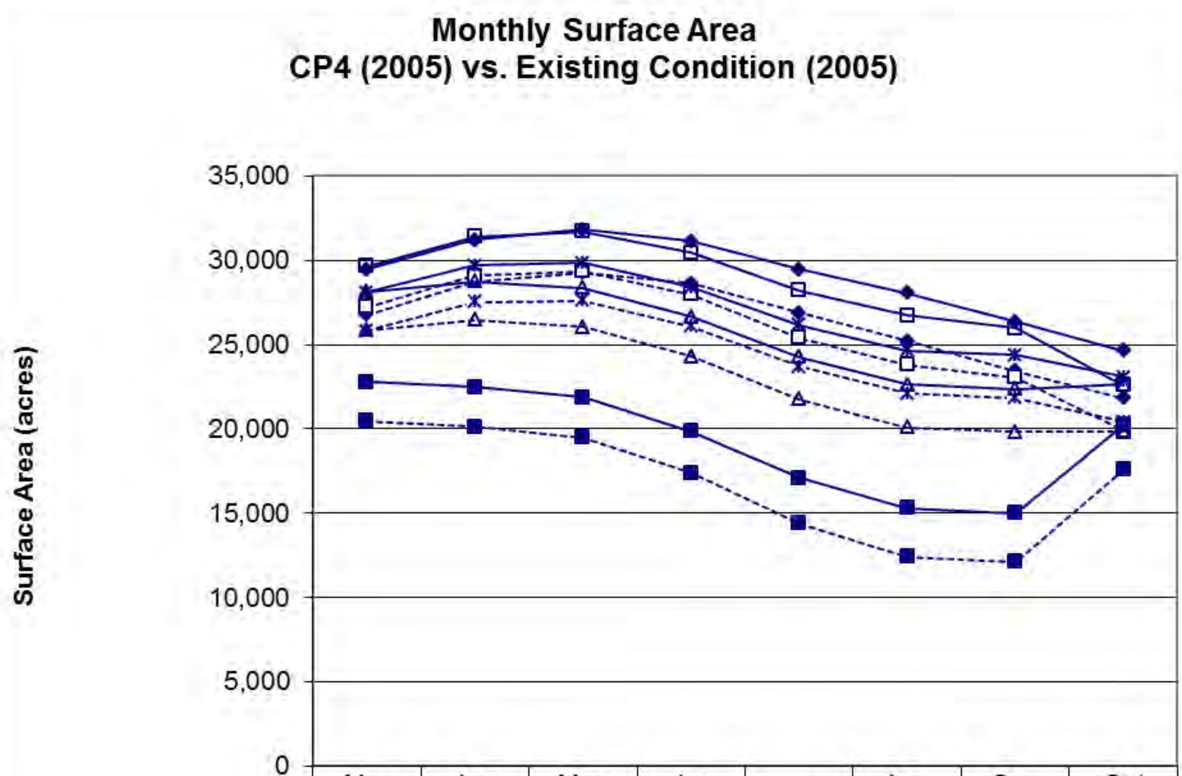
CP2, where the surface area under CP4 would be slightly greater than under CP4A (Figures 11-32 and 11-33). CalSim-II modeling shows that the surface area of Shasta Lake would be larger under CP4 and CP4A for both a 2005 and 2030 water supply demand than under the Existing Condition or the No-Action Alternative in all five water year types (Figures 11-32 through 11-35).

Monthly WSEL fluctuations were compared to projections for water supply demand. For CP4 or CP4A, with a 2005 water supply demand, 76 percent and 68 percent, respectively, of monthly changes in projected WSELs (i.e., 19 and 17 of the 25 total projections made for the 5 months from March through July for all five water year types) showed decreased monthly WSEL fluctuations relative to the Existing Condition and none showed an increased monthly WSEL fluctuation (Figure 11-36 and Figure 11-37). For CP4 or CP4A, with a projected 2030 water supply demand, 72 and 64 percent, respectively, of monthly changes in projected WSELs showed decreased WSEL fluctuations relative to the No-Action Alternative and none showed an increase in monthly WSEL fluctuation (Figure 11-38 and Figure 11-39). Under CP4 or CP4A, none of the changes in monthly WSEL fluctuation are different enough from the Existing Condition to warrant the investigation of daily WSEL fluctuation.

Increases in the overall surface area and WSEL under CP4 or CP4A would increase the area of available warm-water habitat and stimulate biological productivity, including fish production, of the entire lake for a period of time, possibly for several decades. Furthermore, reductions in the magnitude of monthly WSEL fluctuations could contribute to increased reproductive success, young-of-the-year production, and juvenile growth rate of warm-water fish species. Similar to CP1, CP2, and CP3, CP4 and CP4A include environmental commitments during construction to offset the effects on existing fish habitat enhancement structures (see Chapter 2, “Alternatives,” for additional detailed descriptions of the environmental commitments).

This impact for CP4 would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

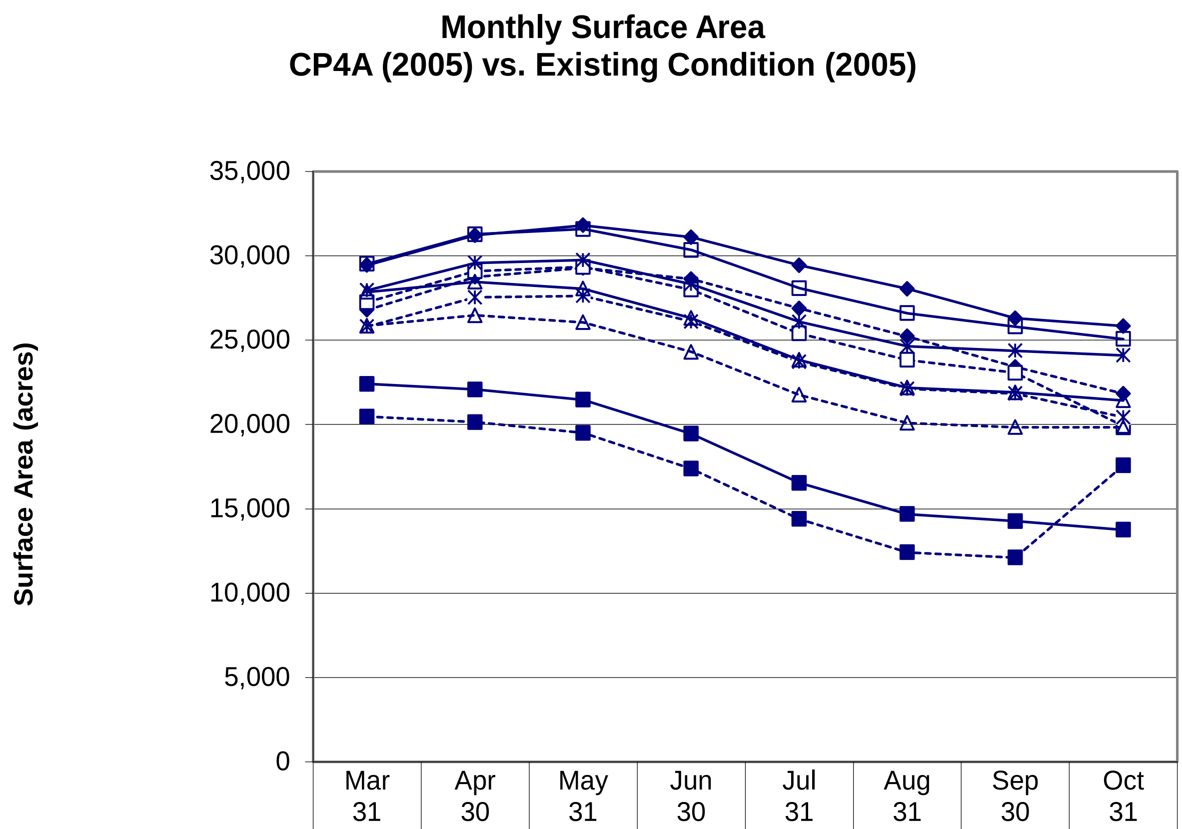
This impact for CP4A would be less than significant. Mitigation for this impact is not needed, and thus not proposed.



	Mar 31	Apr 30	May 31	Jun 30	Jul 31	Aug 31	Sep 30	Oct 31
EC W	26,790	28,748	29,277	28,624	26,872	25,226	23,413	21,827
EC AN	27,245	29,082	29,336	27,992	25,400	23,826	23,061	19,906
EC BN	25,807	27,534	27,621	26,104	23,714	22,114	21,837	20,425
EC D	25,850	26,467	26,058	24,300	21,754	20,093	19,840	19,828
EC C	20,467	20,142	19,500	17,381	14,400	12,418	12,111	17,572
CP4 2005 W	29,449	31,220	31,811	31,125	29,463	28,073	26,342	24,655
CP4 2005 AN	29,658	31,393	31,719	30,465	28,195	26,742	25,983	22,590
CP4 2005 BN	28,094	29,692	29,832	28,406	26,179	24,663	24,362	23,088
CP4 2005 D	28,155	28,742	28,351	26,665	24,248	22,630	22,360	22,625
CP4 2005 C	22,780	22,473	21,856	19,871	17,077	15,320	14,997	20,243

Key:
AN = above-normal water
BN= below-normal water years
C = critical water years
CP = Comprehensive Plan
D = dry water years
EC = Existing Condition
W = wet water years

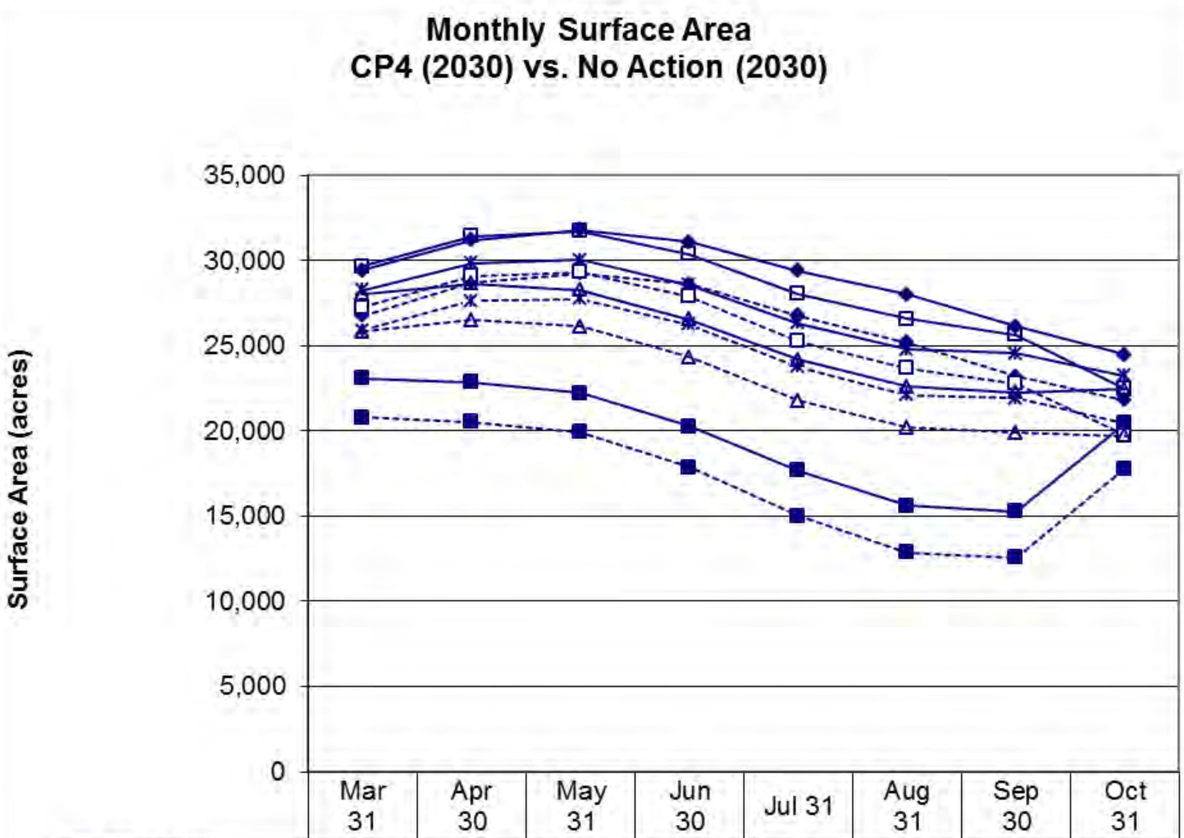
Figure 11-32. Average Monthly Surface Area for Each Water Year Type Within the Shasta Lake Vicinity of the Primary Study Area, CP4 Versus Existing Condition (2005)



	Mar 31	Apr 30	May 31	Jun 30	Jul 31	Aug 31	Sep 30	Oct 31
EC W	26,790	28,748	29,277	28,624	26,872	25,226	23,413	21,827
EC AN	27,245	29,082	29,336	27,992	25,400	23,826	23,061	19,906
EC BN	25,807	27,534	27,621	26,104	23,714	22,114	21,837	20,425
EC D	25,850	26,467	26,058	24,300	21,754	20,093	19,840	19,828
EC C	20,467	20,142	19,500	17,381	14,400	12,418	12,111	17,572
CP4A 2005 W	29,448	31,213	31,802	31,103	29,429	28,044	26,301	25,829
CP4A 2005 AN	29,525	31,277	31,588	30,348	28,075	26,595	25,798	25,066
CP4A 2005 BN	27,954	29,579	29,744	28,324	26,084	24,635	24,366	24,101
CP4A 2005 D	27,852	28,458	28,052	26,304	23,826	22,177	21,896	21,429
CP4A 2005 C	22,400	22,076	21,464	19,451	16,536	14,682	14,273	13,758

Key:
AN = above-normal water
BN= below-normal water years
C = critical water years
CP = Comprehensive Plan
D = dry water years
EC = Existing Condition
W = wet water years

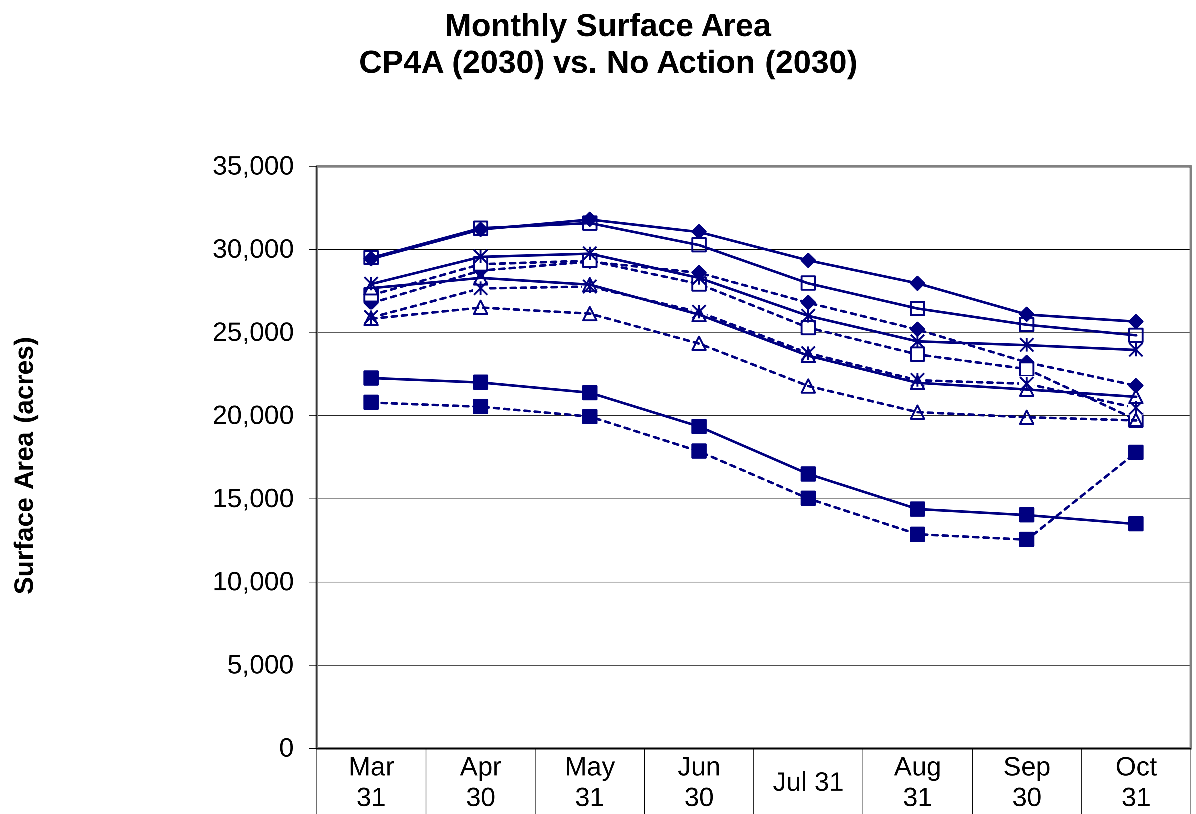
Figure 11-33 Average Monthly Surface Area for Each Water Year Type Within the Shasta Lake Vicinity of the Primary Study Area, CP4A Versus Existing Condition (2005)



	Mar 31	Apr 30	May 31	Jun 30	Jul 31	Aug 31	Sep 30	Oct 31
NA W	26,775	28,735	29,273	28,604	26,797	25,183	23,205	21,808
NA AN	27,258	29,117	29,325	27,921	25,294	23,687	22,800	19,759
NA BN	25,918	27,662	27,770	26,239	23,764	22,137	21,923	20,469
NA D	25,843	26,514	26,134	24,346	21,780	20,209	19,910	19,728
NA C	20,801	20,548	19,942	17,866	15,026	12,873	12,556	17,800
CP4 2030 W	29,436	31,209	31,806	31,089	29,398	28,006	26,152	24,495
CP4 2030 AN	29,677	31,437	31,740	30,369	28,051	26,579	25,658	22,492
CP4 2030 BN	28,276	29,878	30,048	28,591	26,320	24,798	24,567	23,228
CP4 2030 D	28,045	28,663	28,287	26,552	24,182	22,623	22,283	22,451
CP4 2030 C	23,112	22,855	22,235	20,262	17,674	15,624	15,282	20,472

Key:
AN = above-normal water
BN= below-normal water years
C = critical water years
CP = Comprehensive Plan
D = dry water years
EC = Existing Condition
W = wet water years

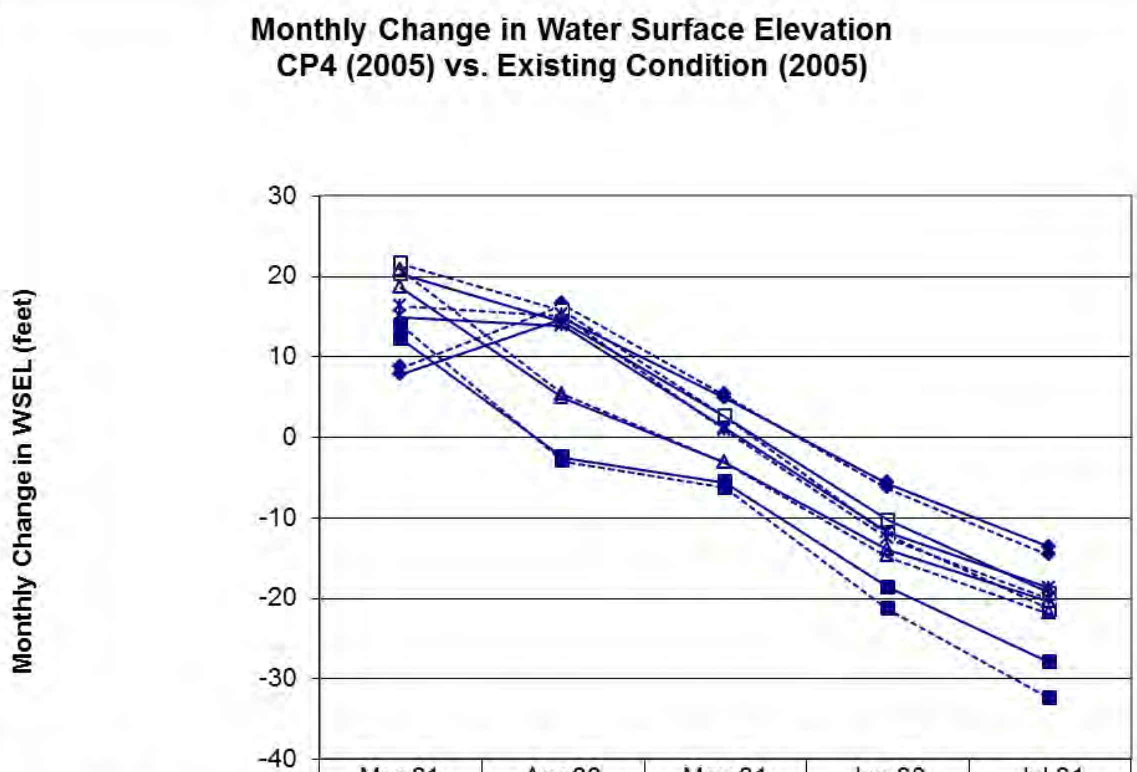
Figure 11-34. Average Monthly Surface Area for Each Water Year Type Within the Shasta Lake Vicinity of the Primary Study Area, CP4 Versus No-Action Alternative (2030)



	Mar 31	Apr 30	May 31	Jun 30	Jul 31	Aug 31	Sep 30	Oct 31
NA W	26,775	28,735	29,273	28,604	26,797	25,183	23,205	21,808
NA AN	27,258	29,117	29,325	27,921	25,294	23,687	22,800	19,759
NA BN	25,918	27,662	27,770	26,239	23,764	22,137	21,923	20,469
NA D	25,843	26,514	26,134	24,346	21,780	20,209	19,910	19,728
NA C	20,801	20,548	19,942	17,866	15,026	12,873	12,556	17,800
CP4A 2030 W	29,436	31,202	31,797	31,057	29,342	27,954	26,086	25,660
CP4A 2030 AN	29,501	31,276	31,582	30,269	27,968	26,440	25,475	24,832
CP4A 2030 BN	27,926	29,555	29,746	28,288	25,998	24,470	24,250	23,965
CP4A 2030 D	27,676	28,279	27,879	26,083	23,617	21,985	21,587	21,142
CP4A 2030 C	22,266	22,009	21,378	19,350	16,490	14,381	14,026	13,496

Key:
AN = above-normal water
BN= below-normal water years
C = critical water years
CP = Comprehensive Plan
D = dry water years
EC = Existing Condition
NA = No-Action
W = wet water years

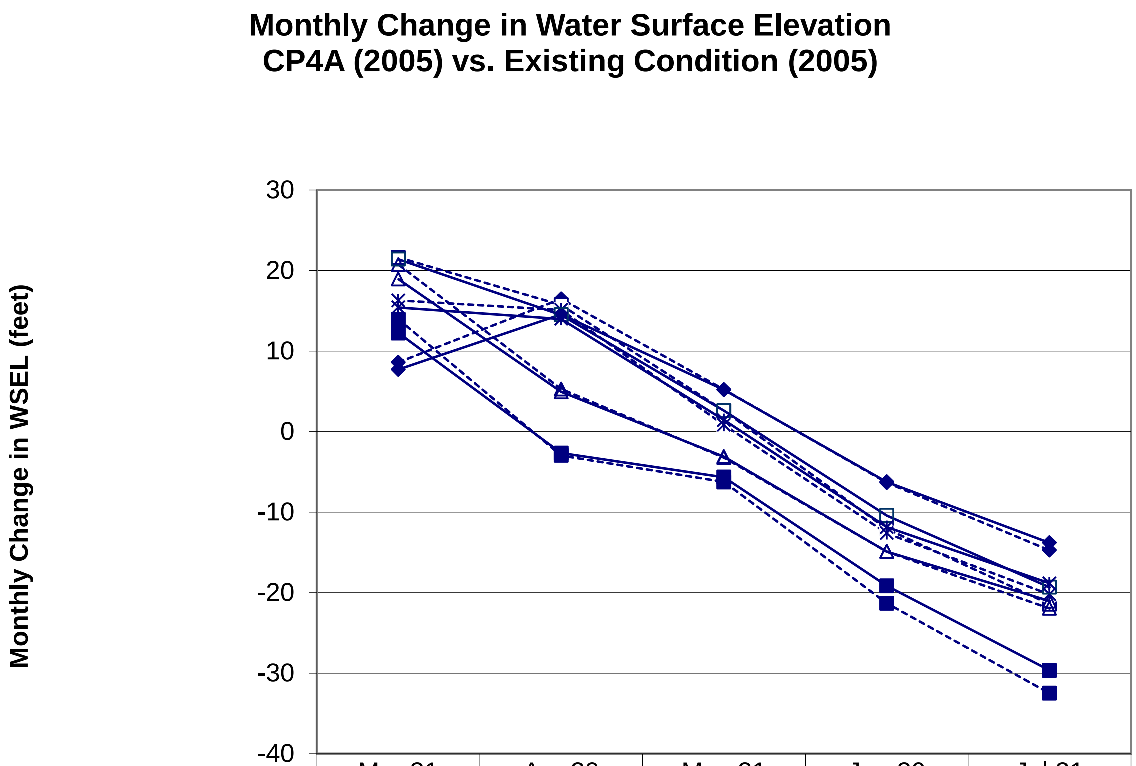
Figure 11-35. Average Monthly Surface Area for Each Water Year Type Within the Shasta Lake Vicinity of the Primary Study Area, CP4A Versus No-Action Alternative (2030)



	Mar 31	Apr 30	May 31	Jun 30	Jul 31
EC W	9	16	5	-6	-15
EC AN	22	16	3	-12	-21
EC BN	16	15	1	-13	-20
EC D	21	5	-3	-15	-22
EC C	14	-3	-6	-21	-32
CP4 (2005) W	8	15	5	-6	-14
CP4 (2005) AN	20	14	3	-10	-19
CP4 (2004) BN	15	14	1	-12	-19
CP4 (2005) D	19	5	-3	-14	-21
CP4 (2005) C	12	-3	-6	-19	-28

Key:
AN = above-normal water
BN= below-normal water years
C = critical water years
CP = Comprehensive Plan
D = dry water years
EC = Existing Condition
W = wet water years
WSEL = water surface elevation

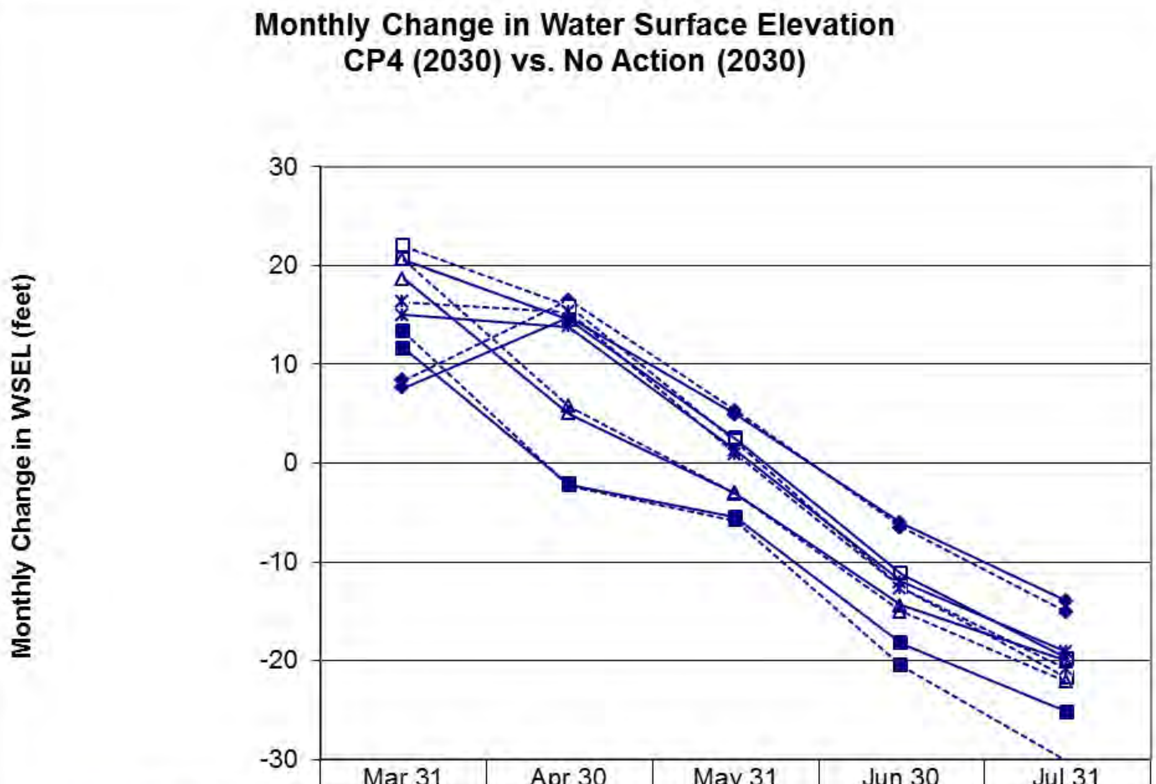
Figure 11-36. Average Monthly Change in Water Surface Elevation for Each Water Year Type Within the Shasta Lake Vicinity of the Primary Study Area, CP4 Versus Existing Condition (2005)



	Mar 31	Apr 30	May 31	Jun 30	Jul 31
EC W	9	16	5	-6	-15
EC AN	22	16	3	-12	-21
EC BN	16	15	1	-13	-20
EC D	21	5	-3	-15	-22
EC C	14	-3	-6	-21	-32
CP4A (2005) W	8	15	5	-6	-14
CP4A (2005) AN	21	15	3	-10	-19
CP4A (2005) BN	15	14	1	-12	-19
CP4A (2005) D	19	5	-3	-15	-21
CP4A (2005) C	12	-3	-6	-19	-30

Key:
AN = above-normal water
BN= below-normal water years
C = critical water years
CP = Comprehensive Plan
D = dry water years
EC = Existing Condition
W = wet water years
WSEL = water surface elevation

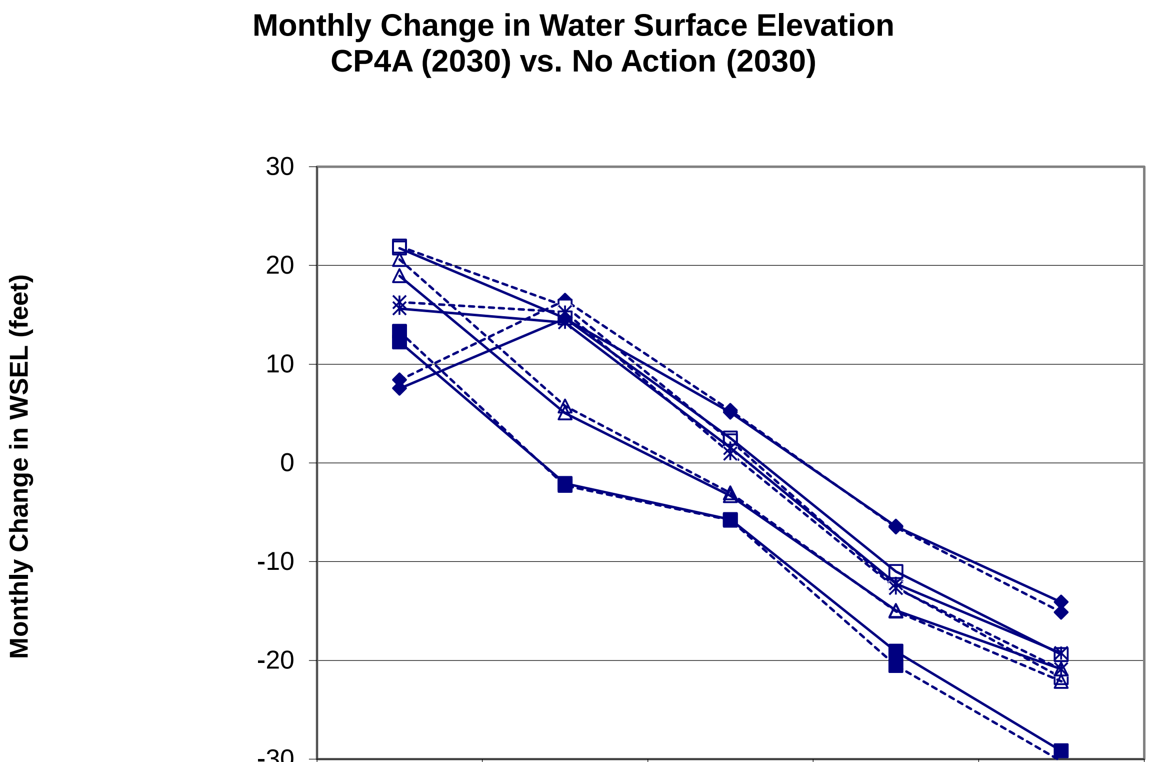
Figure 11-37. Average Monthly Change in Water Surface Elevation for Each Water Year Type Within the Shasta Lake Vicinity of the Primary Study Area, CP4A Versus Existing Condition (2005)



	Mar 31	Apr 30	May 31	Jun 30	Jul 31
NA W	8	16	5	-7	-15
NA AN	22	16	2	-13	-22
NA BN	16	15	1	-13	-21
NA D	21	6	-3	-15	-22
NA C	13	-2	-6	-21	-30
CP4 (2030) W	8	15	5	-6	-14
CP4 (2030) AN	21	14	2	-11	-20
CP4 (2030) BN	15	14	1	-12	-19
CP4 (2030) D	19	5	-3	-14	-20
CP4 (2030) C	12	-2	-6	-18	-25

Key:
AN = above-normal water
BN= below-normal water years
C = critical water years
CP = Comprehensive Plan
D = dry water years
NA = No-Action
W = wet water years
WSEL = water surface elevation

Figure 11-38. Average Monthly Change in Water Surface Elevation for Each Water Year Type Within the Shasta Lake Vicinity of the Primary Study Area, CP4 Versus No-Action Alternative (2030)



	Mar 31	Apr 30	May 31	Jun 30	Jul 31
NA W	8	16	5	-7	-15
NA AN	22	16	2	-13	-22
NA BN	16	15	1	-13	-21
NA D	21	6	-3	-15	-22
NA C	13	-2	-6	-21	-30
CP4A (2030) W	8	15	5	-6	-14
CP4A (2030) AN	22	15	3	-11	-19
CP4A (2030) BN	16	14	2	-12	-19
CP4A (2030) D	19	5	-3	-15	-21
CP4A (2030) C	12	-2	-6	-19	-29

Key:
AN = above-normal water
BN= below-normal water years
C = critical water years
CP = Comprehensive Plan
D = dry water years
NA = No-Action
W = wet water years
WSEL = water surface elevation

Figure 11-39. Average Monthly Change in Water Surface Elevation for Each Water Year Type Within the Shasta Lake Vicinity of the Primary Study Area, CP4A Versus No-Action Alternative (2030)

Impact Aqua-2 (CP4 or CP4A): Effects on Nearshore, Warm-Water Habitat in Shasta Lake from Project Construction This impact would be similar to Impact Aqua-2 (CP3). Localized increases in soil erosion and resulting runoff sedimentation, and turbidity resulting from project construction in the vicinity of Shasta Dam and at utility, road, and other facility relocation areas, could affect nearshore warm-water habitat. However, the environmental commitments for all action alternatives would reduce potential impacts and result in less-than-significant impacts.

This impact for CP4 would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

This impact for CP4A would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

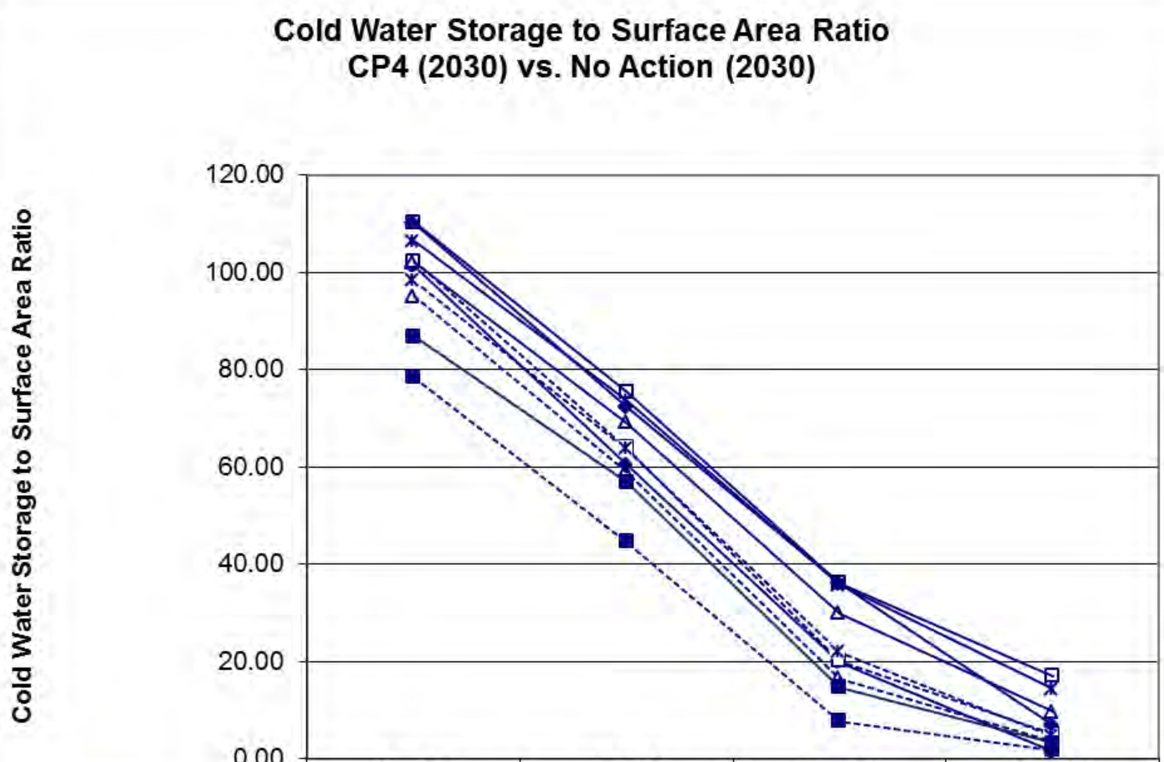
Impact Aqua-3 (CP4 or CP4A): Effects on Cold-Water Habitat in Shasta Lake Operations-related changes in the ratio of cold-water storage to surface area would increase the availability of suitable cold-water habitat in Shasta Lake. This impact would be beneficial for CP4 or CP4A.

This impact would be similar to Impacts Aqua-3 (CP1, CP2, and CP3) but would be of greater benefit to the reservoir cold-water fishery than Aqua-1 (CP3) owing to its focus on increasing the volume of cold water storage available to the TCD to benefit anadromous fish downstream from Shasta Dam.

CalSim-II modeling shows that under CP4 or CP4A, with a 2030 water supply demand, the ratio of cold-water storage to surface area is higher than under the No-Action Alternative in all water years and during all months modeled (Figure 11-33 and Figures 11-34 and 11-35). The greatest projected increases over the No-Action Alternative occurred between June 30 and August 31, which is a critical rearing and oversummering period for cold-water fishes in reservoirs (Figure 11-40 and 11-41).

This impact would be beneficial for CP4. Mitigation for this impact is not needed, and thus not proposed.

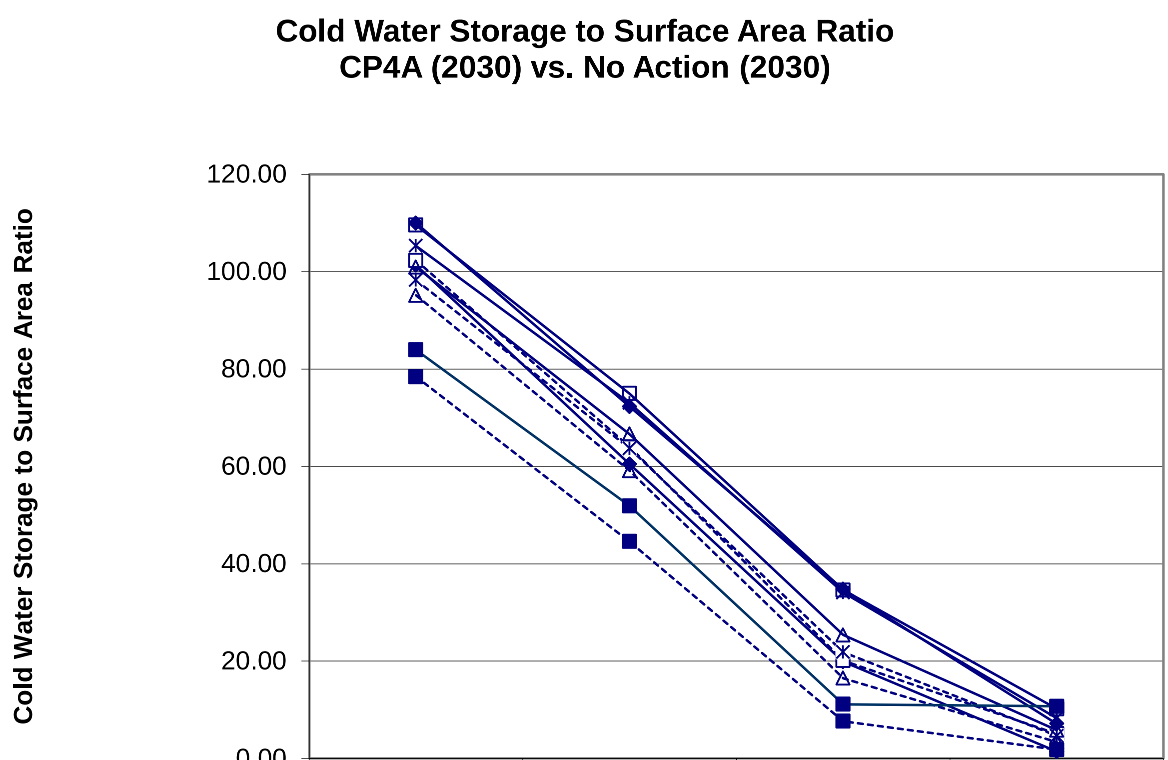
This impact would be beneficial for CP4A. Mitigation for this impact is not needed, and thus not proposed.



	Apr 30	Jun 30	Aug 31	Oct 31
NA W	101.33	60.49	19.89	1.43
NA AN	102.30	64.04	20.12	5.09
NA BN	98.27	63.71	21.84	4.64
NA D	95.13	59.14	16.50	3.38
NA C	78.43	44.58	7.66	1.82
CP4 2030 W	110.16	72.43	36.06	6.87
CP4 2030 AN	110.27	75.42	36.12	17.05
CP4 2030 BN	106.38	73.71	35.68	14.32
CP4 2030 D	102.04	69.13	29.86	9.68
CP4 2030 C	86.77	56.88	14.72	3.13

Key:
AN = above-normal water
BN= below-normal water years
C = critical water years
CP = Comprehensive Plan
D = dry water years
NA = No-Action
W = wet water years

Figure 11-40. Average Monthly Cold-water Storage to Surface Area Ratio for Each Water Year Type Within the Shasta Lake Vicinity of the Primary Study Area, CP4 Versus the No-Action Alternative (2030)



	Apr 30	Jun 30	Aug 31	Oct 31
NA W	101.33	60.49	19.89	1.43
NA AN	102.30	64.04	20.12	5.09
NA BN	98.27	63.71	21.84	4.64
NA D	95.13	59.14	16.50	3.38
NA C	78.43	44.58	7.66	1.82
CP4A 2030 W	109.96	72.29	34.76	7.14
CP4A 2030 AN	109.55	74.97	34.60	10.22
CP4A 2030 BN	105.28	73.02	34.08	8.30
CP4A 2030 D	100.95	66.64	25.36	5.81
CP4A 2030 C	83.92	51.88	11.15	10.71

Key:
AN = above-normal water
BN= below-normal water years
C = critical water years
CP = Comprehensive Plan
D = dry water years
NA = No-Action
W = wet water years

Figure 11-41. Average Monthly Cold-water Storage to Surface Area Ratio for Each Water Year Type Within the Shasta Lake Vicinity of the Primary Study Area, CP4A Versus the No-Action Alternative (2030)

Impact Aqua-4 (CP4 or CP4A): Effects on Special-Status Aquatic Mollusks Under CP4 or CP4A, habitat for special-status mollusks could be inundated. Seasonal fluctuations in the surface area and WSEL of Shasta Lake could adversely affect special-status aquatic mollusks that could occupy habitat in or near Shasta Lake and its tributaries. This impact would be similar to Aqua-4 (CP3).

Except for the California floater, the occurrence of special-status mollusks in Shasta Lake and the lower reaches of its tributaries is unlikely. Modification or loss of suitable habitat for California floater would occur through increased WSEL and seasonal fluctuations in the surface area under CP4 or CP4A. Therefore, this impact would be potentially significant for CP4 or CP4A. Mitigation for this impact would be the same for CP4 or CP4A and is included in Section 11.3.4, "Mitigation Measures."

Impact Aqua-5 (CP4 or CP4A): Effects on Special-Status Fish Species The expansion of the surface area of Shasta Lake and the inundation of additional tributary habitat (including inundation of fish passage barriers) under CP4 or CP4A would be similar to CP3 and could affect one species designated as sensitive by the USFS, the hardhead. Access to, and the availability of, suitable riverine habitat along all the main tributaries to the reservoir would not likely become any more limiting than under current conditions, nor would it greatly expand.

This impact would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

This impact would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact Aqua-6 (CP4 or CP4A): Creation or Removal of Barriers to Fish Between Tributaries and Shasta Lake Under CP4 or CP4A, project implementation would result in the periodic inundation of steep and low-gradient tributaries to Shasta Lake up to the 1,090-foot contour, the maximum inundation level under this alternative. This impact would be less than significant.

Similar to CP3, implementation of CP4 or CP4A could have small localized beneficial effects for adfluvial cold-water fishes and provide access to warm-water fish species, with a potential to alter existing resident fish communities, which would primarily be limited to the newly inundated reaches of the new varial zone of some streams. Impacts would not be expected to be much greater than under existing conditions with implementation of environmental commitments to monitor and adaptively manage to prevent warm-water fish invasion of Squaw Creek (See Chapter 2, "Alternatives," for additional detailed descriptions of the environmental commitments).

This impact is considered to be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

This impact is considered to be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed. *Impact Aqua-7 (CP4 or CP4A): Effects on Spawning and Rearing Habitat of Adfluvial Salmonids in Low-Gradient Tributaries to Shasta Lake* Similar to that described for CP3, CP4 or CP4A would result in additional periodic inundation of potentially suitable spawning and rearing habitat for adfluvial salmonids in the tributaries of the Sacramento River, McCloud River, Pit River, Big Backbone Creek, and Squaw Creek upstream from Shasta Lake. A total of 11 miles of low-gradient reaches that could potentially provide some spawning and rearing habitat for adfluvial salmonids (estimated at 40,103 square feet for all tributaries) would be affected by CP4 or CP4A.

This impact would be potentially significant for CP4. Mitigation for this impact is proposed in Section 11.3.4, “Mitigation Measures.”

This impact would be potentially significant for CP4A. Mitigation for this impact would be the same as that proposed for CP4, and is included in Section 11.3.4, “Mitigation Measures.”

Impact Aqua-8 (CP4 or CP4A): Effects on Aquatic Connectivity in Non-Fish-Bearing Tributaries to Shasta Lake Similar to CP3, CP4 or CP4A would result in periodic inundation of the lower reaches of intermittent high-gradient, non-fish-bearing intermittent tributaries to Shasta Lake. Twenty-four miles of non-fish-bearing tributary stream habitat (based on channel slope and confirmed by surveys of representative stream reaches) upstream from Shasta Lake could be affected by CP4 or CP4A, which is only about 1 percent of the total length of non-fish-bearing tributary habitat upstream from the lake. Field surveys suggest that few, if any, of the non-fish-bearing streams contain special-status invertebrate or vertebrate species that would be affected by increased connectivity to Shasta Lake.

This impact would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

This impact would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact Aqua-9 (CP4 or CP4A): Effects on Water Quality at Livingston Stone Hatchery Reclamation provides the water supply to the Livingston Stone Hatchery from a pipeline emanating from Shasta Dam. This supply would not be interrupted by any activity associated with CP4 or CP4A.

There would be no impact for CP4. Mitigation for this impact is not needed, and thus not proposed.

There would be no impact for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact Aqua-10 (CP4 or CP4A): Loss or Degradation of Aquatic Habitat in the Upper Sacramento River During Construction Activities Temporary construction-related increases in sediments and turbidity levels would adversely affect aquatic habitats and fish populations immediately downstream in the upper Sacramento River. However, environmental commitments would be in place to reduce the effects. This impact would be less than significant for CP4 or CP4A.

Construction activities for CP4 and CP4A are identical. The construction activities and potential borrow sources associated with CP4 or CP4A are described in Section 2.3.8 in Chapter 2, "Alternatives."

This impact would be similar to Impact Aqua-10 (CP1). The impact could be greater under CP4 or CP4A than under CP1 because of the increased activity associated with an 18.5-foot dam raise compared to a 6.5-foot dam raise. Also, CP4 and CP4A include implementation of a 10-year gravel augmentation program as an additional environmental commitment. Placing gravel along the Sacramento River channel and bank annually would release an additional source of fine sediment and expose it to the river and aquatic communities. However, the gravel augmentation activities would occur only during previously specified in-water work windows, which would minimize the potential for impacts associated with this activity.

CP4 and CP4A also include restoration of riparian, floodplain, and side-channel habitat in the upper Sacramento River at up to six potential restoration sites. Riparian, floodplain, and side-channel restoration at these sites could result in additional disturbed surfaces, but most of this construction is expected to occur away from the wetted channel, and all disturbed areas would be revegetated.

The restoration actions and environmental commitments as proposed for either CP4 or CP4A are intended to reduce any potential negative effects.

This impact would be less than significant for CP4. Mitigation for this impact is not needed, and thus is not proposed.

This impact would be less than significant for CP4A. Mitigation for this impact is not needed, and thus is not proposed.

Impact Aqua-11 (CP4 or CP4A): Release and Exposure of Contaminants in the Upper Sacramento River During Construction Activities Construction-related activities could result in the release and exposure of contaminants. Such exposure could adversely affect aquatic habitats, the aquatic food web, and fish populations, including special-status species, downstream in the primary study area. However, environmental commitments would be in place to reduce the effects. Therefore, this impact would be less than significant for CP4 or CP4A.

Construction activities for CP4 and CP4A are identical. The construction activities and potential borrow sources associated with CP4 or CP4A are described in Section 2.3.8 in Chapter 2, “Alternatives.”

This impact would be similar to Impact Aqua-11 (CP1). The impact could be greater under CP4 or CP4A than under CP1 because of the increased activity associated with an 18.5-foot raise compared to a 6.5-foot raise. Additionally, as discussed above, CP4 and CP4A include implementation of a 10-year gravel augmentation program and restoration of riparian, floodplain, and side-channel habitat as additional environmental commitments. Both of these construction activities could cause additional sources of equipment-related contaminants to be released and exposed to the river and aquatic communities. However, implementation of additional environmental commitments that call for in-water work windows and specific BMPs would minimize and/or avoid the potential for impacts associated with this activity. As under CP1, environmental commitments for all actions would be in place to reduce effects.

This impact would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

This impact would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact Aqua-12 (CP4 or CP4A): Changes in Flow and Water Temperature in the Upper Sacramento River Resulting from Project Operation – Chinook Salmon and Steelhead CP4 or CP4A operation would result in generally improved flow and water temperature conditions in the upper Sacramento River for Chinook salmon, steelhead and other native fishes. As well, the restoration actions proposed under CP4 would provide additional benefits to Chinook salmon and steelhead. This impact would be beneficial.

Winter-Run Chinook Salmon

<u>Production</u>

Overall average winter-run production for the 81-year period would be greater under CP4 conditions relative to the No-Action Alternative and Existing Condition (Attachments 3 and 4 of the Modeling Appendix). The maximum increase in simulated production relative to the No-Action Alternative was 369 percent (critical water year), while the largest decrease in production under CP4 relative to the No-Action Alternative was less than -7 percent (above-normal water year) (Table 11-41 and Attachment 3 of the Modeling Appendix). The maximum increase in production relative to the Existing Condition was around 392 percent in 1934 (critical water year) for CP4, while the largest decrease in production relative to the Existing Condition was less than -5 percent CP4 (Table 11-41 and Attachment 4 of the Modeling Appendix). Figure 11-9 shows the change in production relative to the No-Action Alternative for all water years and all Comprehensive Plans.

Under CP4, five critical, one dry, and one wet water year had significant increases in production compared to the No-Action Alternative, while one above-normal water year had a significant decrease in production compared with the No-Action Alternative (Table 11-41 and Attachment 3 of the Modeling Appendix).

Under CP4, six critical and one dry water years had significant increases in production compared to the Existing Condition, while no water years had a significant decrease in production (Table 11-41 and Attachment 4 of the Modeling Appendix).

Table 11-41. Change in Production Under CP4 for Winter-Run Chinook Salmon

Year Type	Number of Years	Average Production	Change in Production from Baseline	Percent Change in Average Production	Maximum Percent Increase in Production	Number of Years with Significant Increase	Maximum Percent Decrease in Production	Number of Years with Significant Decrease
Future Condition (2030)								
All	81	3,863,877	62,762	1.7	369	7	-6.7	1
Critical	13	3,958,608	580,652	17.2	369	5	-3.0	0
Dry	17	3,961,832	-10,499	-0.3	6.6	1	-3.3	0
Below Normal	14	3,924,052	-14,506	-0.4	3.5	0	-3.9	0
Above Normal	11	3,782,793	-76,137	-2.0	0.3	0	-6.7	1
Wet	26	3,754,368	-47,911	-1.3	5.7	1	-4.3	0
Existing Condition (2005)								
All	81	3,868,418	87,171	2.3	392	7	-4.7	0
Critical	13	3,934,478	723,539	22.5	392	6	-1.9	0
Dry	17	3,979,718	-4,144	-0.1	16.0	1	-4.3	0
Below Normal	14	3,908,625	-31,525	-0.8	4.6	0	-4.7	0
Above Normal	11	3,808,985	-43,697	-1.1	3.8	0	-3.7	0
Wet	26	3,766,110	-52,025	-1.4	1.0	0	-4.3	0

Note:

Production is the number of immature smolts surviving to pass the Red Bluff Pumping Plant

Key:
CP = Comprehensive Plan

Under CP4A, overall average winter-run production for the 81-year period would be greater relative to the No-Action Alternative and Existing Condition (Attachments 3 and 4 of the Modeling Appendix). The maximum increase in simulated production relative to the No-Action Alternative was 255 percent (critical water year), while the largest decrease in production under CP4A relative to the No-Action Alternative was -5 percent (critical water year) (Table 11-42 and Attachment 3 of the Modeling Appendix). The maximum increase in production relative to the Existing Condition was around 258 percent (critical water year) for CP4A, while the largest decrease in production relative to the Existing Condition was less than -6 percent for CP4A (wet water year) (Table 11-42 and Attachment 4 of the Modeling Appendix). Figure 11-9 shows the change in production relative to the No-Action Alternative for all water years and all Comprehensive Plans.

Under CP4A, four critical and one dry water year had significant increases in production compared to the No-Action Alternative, while one critical water year had a significant decrease in production compared with the No-Action Alternative (Table 11-42 and Attachment 3 of the Modeling Appendix).

Under CP4A, six critical and one dry water years had significant increases in production compared to the Existing Condition, while one wet water year had a significant decrease in production (Table 11-42 and Attachment 4 of the Modeling Appendix).

Table 11-42. Change in Production Under CP4A for Winter-Run Chinook Salmon

Year Type	Number of Years	Average Production	Change in Production from Baseline	Percent Change in Average Production	Maximum Percent Increase in Production	Number of Years with Significant Increase	Maximum Percent Decrease in Production	Number of Years with Significant Decrease
Future Condition (2030)								
All	81	3,829,067	27,952	0.7	255.1	5	-5.0	1
Critical	13	3,692,529	314,574	9.3	255.1	4	-5.0	1
Dry	17	3,991,112	18,781	0.5	12.1	1	-2.6	0
Below Normal	14	3,924,788	-13,771	-0.3	3.6	0	-3.1	0
Above Normal	11	3,815,033	-43,897	-1.1	2.3	0	-4.2	0
Wet	26	3,745,780	-56,498	-1.5	3.7	0	-4.0	0
Existing Condition (2005)								
All	81	3,836,508	55,262	1.5	257.5	7	-5.5	1
Critical	13	3,749,170	538,231	16.8	257.5	6	-3.1	0
Dry	17	3,976,140	-7,721	-0.2	16.9	1	-4.3	0
Below Normal	14	3,930,274	-9,876	-0.3	3.6	0	-3.2	0
Above Normal	11	3,804,642	-48,040	-1.2	3.7	0	-4.0	0
Wet	26	3,751,872	-66,263	-1.7	1.1	0	-5.5	1

Note:
Production is the number of immature smolts surviving to pass the Red Bluff Pumping Plant

Key:
CP = Comprehensive Plan

Mortality

Mortality was separated by flow- and water temperature-related mortality to assess the level of impacts on winter-run Chinook salmon caused by the actions of the project (Attachments 3 and 4 of the Modeling Appendix). Nonoperations-related mortality is the base and seasonal mortality that would occur even without the effects of Shasta operations (such as disease, predation, and entrainment). Flow- and water temperature-related mortality is that caused by altering flow and water temperatures. In all cases, most mortality is caused by nonoperations-related factors (e.g., disease, predation, entrainment)−around 89 percent of the total mortality under CP4 and around 88 percent of the total mortality under CP4A.

Mortality is presented in two manners–total mortality and smolt equivalent mortality (Attachments 3 and 4 of the Modeling Appendix). Under both 2030 and 2005 conditions, the greatest average mortality to winter-run Chinook salmon under CP4 and CP4A (as with CP1 through CP3) in all water year types, based on smolt equivalents, would occur to fry, followed by eggs, presmolts, immature smolts, and prespawn adults. Table 11-5 displays the overall mortalities for each Comprehensive Plan that would be caused by changes in water temperature and flow (see also Attachments 3 and 4 of the Modeling Appendix). Under CP4, years with the highest mortality were different between CP4, No-Action Alternative and Existing Conditions and included critical, dry and wet water year types. These years with highest mortality were preceded by three critical, and three dry water years. Years with the lowest mortality varied between all water year types (Attachments 3 and 4).

Under CP4A, years with the highest mortality were different between CP4A, No-Action Alternative and Existing Conditions and included critical, dry and wet water year types. These years with highest mortality were preceded by three critical, and three dry water years. Years with the lowest mortality varied between all water year types (Attachments 3 and 4).

Under CP4, winter-run Chinook salmon would have, overall, a significant reduction in project-related mortality relative to the No-Action Alternative and Existing Condition. Winter-run Chinook salmon would have an overall insignificant increase in production, but a significant increase in production during critical water years–those years in which they are at greatest risk. Therefore, winter-run Chinook salmon would benefit from water temperature and flow conditions under in CP4. Additionally, winter-run Chinook salmon will likely benefit from the downstream restoration program, although this was not modeled with SALMOD. Mitigation for this impact is not needed, and thus not proposed.

Under CP4A, winter-run Chinook salmon would have, overall, a significant reduction in project-related mortality relative to the No-Action Alternative (6 percent and the Existing Conditions. Winter-run Chinook salmon would have an overall insignificant increase in production, but a significant increase in production during critical water years–those years in which they are at greatest risk. Therefore, winter-run Chinook salmon would benefit from water temperature and flow conditions under in CP4A. Additionally, winter-run Chinook salmon will benefit from the downstream restoration program, although this was not modeled with SALMOD. Mitigation for this impact is not needed, and thus not proposed.

Spring-Run Chinook Salmon

Production

Overall average spring-run Chinook salmon production increased for the 82-year period under CP4 compared to the No-Action Alternative and the Existing Condition (Attachments 6 and 7 of the Modeling Appendix). The maximum increase in simulated production relative to the No-Action Alternative was 6,006 percent for CP4 (critical water year). The largest decrease in production relative to the No-Action Alternative was -8 percent for CP4 (wet water year) (Table 11-43 and Attachment 6 of the Modeling Appendix). The maximum increase in production relative to the Existing Condition was 5,516 percent for CP4 (critical water year). The largest decrease in production relative to the Existing Condition was -8.5 percent for CP4 (wet water year) (Table 11-43 and Attachment 7 of the Modeling Appendix). Figure 11-10 shows the change in production relative to the No-Action Alternative for all water years and all Comprehensive Plans.

Under CP4, 12 critical, two dry, one below-normal, and one above-normal water years had significant increases in production compared to the No-Action Alternative. One each dry, below-normal and wet water years had significant decreases in production (Table 11-43 and Attachment 6 of the Modeling Appendix).

Under CP4, 12 critical, one dry, and one below-normal water years had significant increases in production compared to the Existing Condition. Two wet water years had significant decreases in production (Table 11-43and Attachment 7 of the Modeling Appendix).

Table 11-43. Change in Production Under CP4 for Spring-Run Chinook Salmon

Year Type	Number of Years	Average Production	Change in Production from Baseline	Percent Change in Average Production	Maximum Percent Increase in Production	Number of Years with Significant Increase	Maximum Percent Decrease in Production	Number of Years with Significant Decrease
Future Condition (2030)								
All	81	169,926	5,871	3.6	6006	16	-8.1	3
Critical	13	116,448	35,259	43.4	6006	12	0.4	0
Dry	17	178,300	8,848	5.2	1844	2	-5.2	1
Below Normal	14	178,039	859	0.5	36.3	1	-5.3	1
Above Normal	11	181,294	-2,472	-1.3	5.5	1	-4.6	0
Wet	26	182,011	-4,539	-2.4	0.5	0	-8.1	1
Existing Condition (2005)								
All	81	170,326	7,119	4.4	5516	16	-8.5	2
Critical	13	116,199	42,136	56.9	5516	12	4.9	0
Dry	17	179,369	10,508	6.2	2485	3	-4.9	0
Below Normal	14	179,032	1,002	0.6	34.4	1	-3.9	0
Above Normal	11	180,906	-3,208	-1.7	3.3	0	-4.7	0
Wet	26	182,314	-4,944	-2.6	0.5	0	-8.5	2

Note:

Production is the number of immature smolts surviving to pass the Red Bluff Pumping Plant

Key:

CP = Comprehensive Plan

Overall average spring-run Chinook salmon production increased for the 82-year period under CP4A compared to the No-Action Alternative and the Existing Condition (Attachments 6 and 7 of the Modeling Appendix). The maximum increase in simulated production relative to the No-Action Alternative was 1,480 percent for CP4A (critical water year), while the largest decrease in production relative to the No-Action Alternative was -5 percent for CP4A (wet water year) (Table 11-44 and Attachment 6 of the Modeling Appendix). The maximum increase in production relative to the Existing Condition was 2,258 percent for CP4A (dry water year), while the largest decrease in production relative to the Existing Condition was -8.3 percent for CP4A (wet water year) (Table 11-44 and Attachment 7 of the Modeling Appendix). Figure 11-10 shows the change in production relative to the No-Action Alternative for all water years and all Comprehensive Plans.

Under CP4A, 12 critical, three dry, one below-normal, and one above-normal water years had significant increases in production compared to the No-Action Alternative. Two wet water years had significant decreases in production (Table 11-44 and Attachment 6 of the Modeling Appendix).

Under CP4A, 12 critical, three dry, and one below-normal water years had significant increases in production compared to the Existing Condition. Two wet water years had significant decreases in production (Table 11-44 and Attachment 7 of the Modeling Appendix).

Table 11-44. Change in Production Under CP4A for Spring-Run Chinook Salmon

Year Type	Number of Years	Average Production	Change in Production from Baseline	Percent Change in Average Production	Maximum Percent Increase in Production	Number of Years with Significant Increase	Maximum Percent Decrease in Production	Number of Years with Significant Decrease
Future Condition (2030)								
All	81	168,055	4,000	2.4	1,480.1	17	-5.2	2
Critical	13	104,764	23,575	29.0	672.6	12	4.9	0
Dry	17	177,719	8,267	4.9	1,480.1	3	-3.9	0
Below Normal	14	177,251	71	0.0	25.3	1	-3.9	0
Above Normal	11	181,171	-2,595	-1.4	5.4	1	-4.2	0
Wet	26	182,879	-3,672	-2.0	1.2	0	-5.2	2
Existing Condition (2005)								
All	81	168,752	5,544	3.4	2,258.4	16	-8.3	2
Critical	13	106,842	32,779	44.3	1,412.9	12	4.2	0
Dry	17	179,095	10,234	6.1	2,258.4	3	-3.3	0
Below Normal	14	178,145	115	0.1	30.3	1	-3.4	0
Above Normal	11	180,926	-3,188	-1.7	3.2	0	-4.3	0
Wet	26	182,736	-4,522	-2.4	1.5	0	-8.3	2

Note:
Production is the number of immature smolts surviving to pass the Red Bluff Pumping Plant

Key:
CP = Comprehensive Plan

Mortality

Mortality was separated by flow- and water temperature-related mortality to assess the level of impacts on spring-run Chinook salmon caused by the actions of the project (Attachments 6 and 7). In all cases, most mortality is caused by nonoperations-related factors (e.g., disease, predation, entrainment)‒around 89 percent of the total mortality under CP4 and 87 percent of the total mortality under CP4A.

Mortality is presented in two manners–total mortality and smolt equivalent mortality (Attachments 6 and 7 of the Modeling Appendix). Under both the 2030 and 2005 conditions, the greatest mortality to spring-run Chinook salmon under CP4 and CP4A (as with CP1 through CP3) in all water year types based on smolt equivalents, occurred to eggs, with minimal mortality to the other life stages. Table 11-7 displays the smolt-equivalent mortalities for each Comprehensive Plan that are caused by flow- and water-related factors (also see Attachments 6 and 7 of the Modeling Appendix).

Years with the highest operations-related mortality were different for CP4 and CP4A compared with No-Action Alternative and Existing Conditions with fewer years with high mortality. All years with the highest mortality were preceded by either a critical or dry water year. Years with the lowest mortality varied between all water year types (Attachments 6 and 7 of the Modeling Appendix).

Spring-run Chinook salmon would have significantly reduced flow- and water temperature-related mortality under CP4 and CP4A, but an insignificant increase in overall production. However, they would experience a significant increase in production during almost all critical water years, and a significant increase in average production during critical years, under CP4 and CP4A. Therefore, spring-run Chinook salmon would benefit from actions taken in CP4 and CP4A. Additionally, spring-run Chinook salmon will benefit from the downstream restoration program, although this was not modeled with SALMOD. Mitigation for this impact is not needed, and thus not proposed.

Fall-Run Chinook Salmon

Production

Overall average fall-run Chinook salmon production under CP4 increased for the 81-year period compared with the No-Action Alternative and Existing Condition (Attachments 9 and 10 of the Modeling Appendix). The maximum increase in simulated production relative to the No-Action Alternative was 617 percent (critical water year), while the largest decrease in production relative to the No-Action Alternative was -6.5 percent (wet water year) (Table 11-45 and Attachment 9 of the Modeling Appendix). The maximum increase in production relative to the Existing Condition was 656 percent (critical water year). The largest decrease in production relative to the Existing Condition was -6.7 percent (wet water year) (Table 11-45 and Attachment 10 of the Modeling

Appendix). Figure 11-11 shows the change in production relative to the No-Action Alternative for all water years and all Comprehensive Plans.

Under CP4, five critical, three dry, and one above-normal water years had significant increases in production relative to the No-Action Alternative. Significant reductions in production occurred in two dry, one below-normal, and three wet water years (Table 11-45 and Attachment 9 of the Modeling Appendix).

Under CP4, five critical, three dry, and two below-normal water years had significant increases in production relative to the Existing Condition. One dry, one below-normal, and two wet water years resulted in significant decreases in production relative to the Existing Condition (Table 11-45 and Attachment 10 of the Modeling Appendix).

Table 11-45. Change in Production Under CP4 for Fall-Run Chinook Salmon

Year Type	Number of Years	Average Production	Change in Production from Baseline	Percent Change in Average Production	Maximum Percent Increase in Production	Number of Years with Significant Increase	Maximum Percent Decrease in Production	Number of Years with Significant Decrease
No-Action Alternative								
All	81	30,134,465	616,059	2.1	617	9	-6.5	6
Critical	13	31,842,200	5,397,372	20.4	617	5	-3.0	0
Dry	17	29,597,381	57,220	0.2	20.2	3	-5.7	2
Below Normal	14	30,794,778	-303,133	-1.0	15.8	1	-5.9	1
Above Normal	11	30,633,357	-399,653	-1.3	3.6	0	-4.1	0
Wet	26	29,065,145	-484,530	-1.6	2.5	0	-6.5	3
Existing Conditions								
All	81	30,309,575	881,234	3.0	656	10	-6.7	5
Critical	13	32,618,696	6,442,560	24.6	656	5	-0.3	0
Dry	17	29,773,255	312,854	1.1	35.8	3	-5.4	1
Below Normal	14	30,960,930	-57,332	-0.2	25.2	2	-5.1	1
Above Normal	11	30,419,848	-450,549	-1.5	1.9	0	-4.0	0
Wet	26	29,108,303	-458,967	-1.6	4.4	0	-6.7	3

Note:

Production is the number of immature smolts surviving to pass the Red Bluff Pumping Plant

Key:
CP = Comprehensive Plan

Overall average fall-run Chinook salmon production under CP4A increased for the 81-year period compared with the No-Action Alternative and Existing Condition (Attachments 9 and 10 of the Modeling Appendix). The maximum increase in simulated production relative to the No-Action Alternative was 75 percent (critical water year). The largest decrease in production relative to the No-Action Alternative was -6.4 percent (wet water year) (Table 11-46 and Attachment 9 of the Modeling Appendix). The maximum increase in production relative to the Existing Condition was 148 percent (critical water year). The largest decrease in production relative to the Existing Condition was -6.7 percent (wet water year) (Table 11-46 and Attachment 10 of the Modeling Appendix). Figure 11-11 shows the change in production relative to the No-Action Alternative for all water years and all Comprehensive Plans.

Under CP4A, six critical, three dry, and two below-normal water years had significant increases in production relative to the No-Action Alternative. Significant reductions in production occurred in one below-normal and one wet water years (Table 11-46 and Attachment 9 of the Modeling Appendix).

Under CP4A, six critical, four dry, one below-normal, and one wet water years had significant increases in production relative to the Existing Condition. Significant reductions in production occurred in one wet water year (Table 11-46 and Attachment 10 of the Modeling Appendix).

Table 11-46. Change in Production Under CP4A for Fall-Run Chinook Salmon

Year Type	Number of Years	Average Production	Change in Production from Baseline	Percent Change in Average Production	Maximum Percent Increase in Production	Number of Years with Significant Increase	Maximum Percent Decrease in Production	Number of Years with Significant Decrease
No-Action Alternative								
All	81	30,109,242	590,836	2.0	75.5	11	-6.4	2
Critical	13	29,789,070	3,344,242	12.6	75.5	6	0.4	0
Dry	17	30,223,299	683,138	2.3	21.7	3	-4.1	0
Below Normal	14	31,239,907	141,996	0.5	22.1	2	-5.3	1
Above Normal	11	30,736,255	-296,755	-1.0	4.0	0	-3.8	0
Wet	26	29,320,660	-229,016	-0.8	4.6	0	-6.4	1
Existing Conditions								
All	81	30,072,774	644,433	2.2	148.2	12	-6.7	1
Critical	13	30,021,716	3,845,580	14.7	148.2	6	-1.7	0
Dry	17	30,024,883	564,482	1.9	35.1	4	-3.6	0
Below Normal	14	31,215,490	197,228	0.6	37.5	1	-4.1	0
Above Normal	11	30,663,690	-206,707	-0.7	1.5	0	-4.4	0
Wet	26	29,264,305	-302,965	-1.0	5.7	1	-6.7	1

Note:

Production is the number of immature smolts surviving to pass the Red Bluff Pumping Plant

Key:

CP = Comprehensive Plan

Mortality

Mortality was separated by flow- and water temperature-related mortality to assess the level of impacts on fall-run Chinook salmon caused by the actions of the project (Attachments 9 and 10). In all cases, most mortality is caused by nonoperations-related factors (e.g., disease, predation, entrainment)‒around 66 percent of the total mortality under CP4 and around 65 percent of the total mortality under CP4A.

Mortality is presented in two manners–total mortality and smolt equivalent mortality (Attachments 9 and 10 of the Modeling Appendix). Under both 2030 and 2005 conditions, the greatest mortality based on the smolt equivalents to fall-run Chinook salmon under CP4 and CP4A (as with CP1 through CP3) in all water year types based on smolt equivalents occurred to fry, followed by eggs, prespawn adults, presmolts, and lastly to immature smolts. Flow-related effects triggered a higher percentage of the operations-related mortality (Table 11-9). In all water year types, the greatest portion of mortality under CP4 and CP4A occurred to fry caused by forced movement to downstream habitats. Other non-flow- and water temperature-related conditions were the primary causes of mortality for all life stages except fry (Attachments 9 and 10 in the Modeling Appendix).

There was no real trend with respect to years with the greatest mortality.

Fall-run Chinook salmon would have significantly reduced project-related mortality, but an insignificant increase in overall production However, fall-run Chinook salmon would experience a significant overall average increase in production during critical water years under CP4 and CP4A. Therefore, fall-run Chinook salmon would benefit from actions taken in CP4 and CP4A. Additionally, fall-run Chinook salmon will benefit from the downstream restoration program, although this was not modeled with SALMOD. Mitigation for this impact is not needed, and thus not proposed.

Late Fall-Run Chinook Salmon and Steelhead

Late fall-run Chinook salmon were evaluated directly using SALMOD and were considered to be a surrogate for steelhead; therefore, the following discussion regarding SALMOD results for late fall-run Chinook salmon are applicable to steelhead.

Production

Overall average late fall-run Chinook salmon production for the 80-year period under CP4 conditions was slightly greater than the No-Action Alternative and the Existing Condition (Attachments 12 and 13 of the Modeling Appendix). The maximum increase in production relative to the No-Action Alternative was 23 percent (critical water year), while there were no significant decreases in production relative to the No-Action Alternative (Table 11-47 and Attachment 12 of the Modeling Appendix). The maximum increase in production relative to Existing Conditions was 27 percent (critical water year), there were no significant decreases in production relative to Existing Conditions (Table 11-47 and Attachment 13 of the Modeling Appendix). Figure 11-12 shows the change in production relative to the No-Action Alternative for all water years and all Comprehensive Plans.

Under CP4, six critical and five dry water years had significant increases in production compared to the No-Action Alternative. Significant reductions in production did not occur in any years (Table 11-47 and Attachment 12 of the Modeling Appendix).

Under CP4, four critical, four dry, one below-normal, and two wet water years had significant increases in production compared to the Existing Condition. Significant reductions in production did not occur in any years (Table 11-47 and Attachment 13 of the Modeling Appendix).

Table 11-47. Change in Production Under CP4 for Late Fall-Run Chinook Salmon

Year Type	Number of Years	Average Production	Change in Production from Baseline	Percent Change in Average Production	Maximum Percent Increase in Production	Number of Years with Significant Increase	Maximum Percent Decrease in Production	Number of Years with Significant Decrease
Future Condition (2030)								
All	80	7,546,347	127,861	1.7	23.0	11	-4.7	0
Critical	13	7,382,128	317,959	4.5	23.0	6	-1.8	0
Dry	16	7,577,473	223,104	3.0	13.5	5	-1.7	0
Below Normal	14	7,671,893	59,275	0.8	3.8	0	-1.4	0
Above Normal	11	7,658,120	72,036	0.9	3.8	0	-1.7	0
Wet	26	7,494,413	34,749	0.5	4.4	0	-4.7	0
Existing Condition (2005)								
All	80	7,539,887	153,326	2.1	27.0	11	-3.5	0
Critical	13	7,333,049	369,753	5.3	27.0	4	-2.6	0
Dry	16	7,587,721	227,453	3.1	15.8	4	-3.3	0
Below Normal	14	7,652,128	41,034	0.5	5.9	1	-3.5	0
Above Normal	11	7,649,290	89,617	1.2	4.6	0	-1.4	0
Wet	26	7,507,147	86,915	1.2	6.7	2	-2.1	0

Note:

Production is the number of immature smolts surviving to pass the Red Bluff Pumping Plant

Late fall-run Chinook salmon are used as a surrogate for steelhead

Key:

CP = Comprehensive Plan

Overall average late fall-run Chinook salmon production for the 80-year period under CP4A conditions was slightly greater than the No-Action Alternative and the Existing Condition (Attachments 12 and 13 of the Modeling Appendix). The maximum increase in production relative to the No-Action Alternative was 15 percent (dry water year), while there were no significant decreases in production relative to the No-Action Alternative (Table 11-48 and Attachment 12 of the Modeling Appendix). The maximum increase in production relative to Existing Conditions was 19 percent (dry water year), while the maximum decrease in production relative to Existing Condition was -6.3 percent (dry water year) (Table 11-48 and Attachment 12 of the Modeling Appendix). Figure 11-12 shows the change in production for CP4A relative to the No-Action Alternative for all water years and all Comprehensive Plans.

Under CP4A, three critical and four dry water years had significant increases in production compared to the No-Action Alternative. Significant reductions in production did not occur in any years (Table 11-48 and Attachment 12 of the Modeling Appendix).

Under CP4A, four critical, three dry, one below-normal, and two wet water years had significant increases in production compared to the Existing Condition. A significant reduction in production occurred in one dry water year (Table 11-48 and Attachment 13 of the Modeling Appendix).

Table 11-48. Change in Production Under CP4A for Late Fall-Run Chinook Salmon

Year Type	Number of Years	Average Production	Change in Production from Baseline	Percent Change in Average Production	Maximum Percent Increase in Production	Number of Years with Significant Increase	Maximum Percent Decrease in Production	Number of Years with Significant Decrease
Future Condition (2030)								
All	80	7,505,702	87,215	1.2	15.4	7	-3.6	0
Critical	13	7,198,719	134,550	1.9	12.0	3	-2.3	0
Dry	16	7,544,632	190,263	2.6	15.4	4	-3.6	0
Below Normal	14	7,605,476	-7,142	-0.1	2.1	0	-2.6	0
Above Normal	11	7,667,964	81,880	1.1	2.6	0	-0.8	0
Wet	26	7,512,863	53,199	0.7	4.3	0	-3.2	0
Existing Condition (2005)								
All	80	7,495,910	109,349	1.5	18.5	10	-6.3	1
Critical	13	7,216,641	253,345	3.6	14.5	4	-3.4	0
Dry	16	7,566,038	205,770	2.8	18.5	3	-6.3	1
Below Normal	14	7,605,024	-6,070	-0.1	6.3	1	-4.9	0
Above Normal	11	7,597,778	38,105	0.5	2.3	0	-3.0	0
Wet	26	7,490,537	70,305	0.9	7.1	2	-4.1	0

Note:

Production is the number of immature smolts surviving to pass the Red Bluff Pumping Plant

Late fall-run Chinook salmon are used as a surrogate for steelhead

Key:

CP = Comprehensive Plan

Mortality

Mortality was separated by flow- and water temperature-related mortality to assess the level of impacts on late fall-run Chinook salmon caused by the actions of the project (Attachments 12 and 13). In all cases, most mortality is caused by nonoperations-related factors (e.g., disease, predation, entrainment)−around 79 percent of the total mortality under both CP4 and CP4A.

Mortality is presented in two manners–total mortality and smolt equivalent mortality (Attachments 12 and 13 of the Modeling Appendix). Under both 2030 and 2005 conditions, the largest mortality to late fall-run Chinook salmon under CP4 and CP4A (as with CP1 through CP3) in all water year types based on smolt equivalents, occurred to the egg life stage, followed by fry, then presmolts, and lastly to immature smolts. Most mortality occurred as a result of flow conditions rather than water temperature (Table 11-11).

Years with the highest mortality were the same for CP4 and CP4A and the No-Action Alternative and the Existing Condition, and occurred in all water year types. Four of these years were preceded by a wet water year, and the rest were each preceded by an above-normal, below-normal or dry water year (Attachments 12 and 13 of the Modeling Appendix).

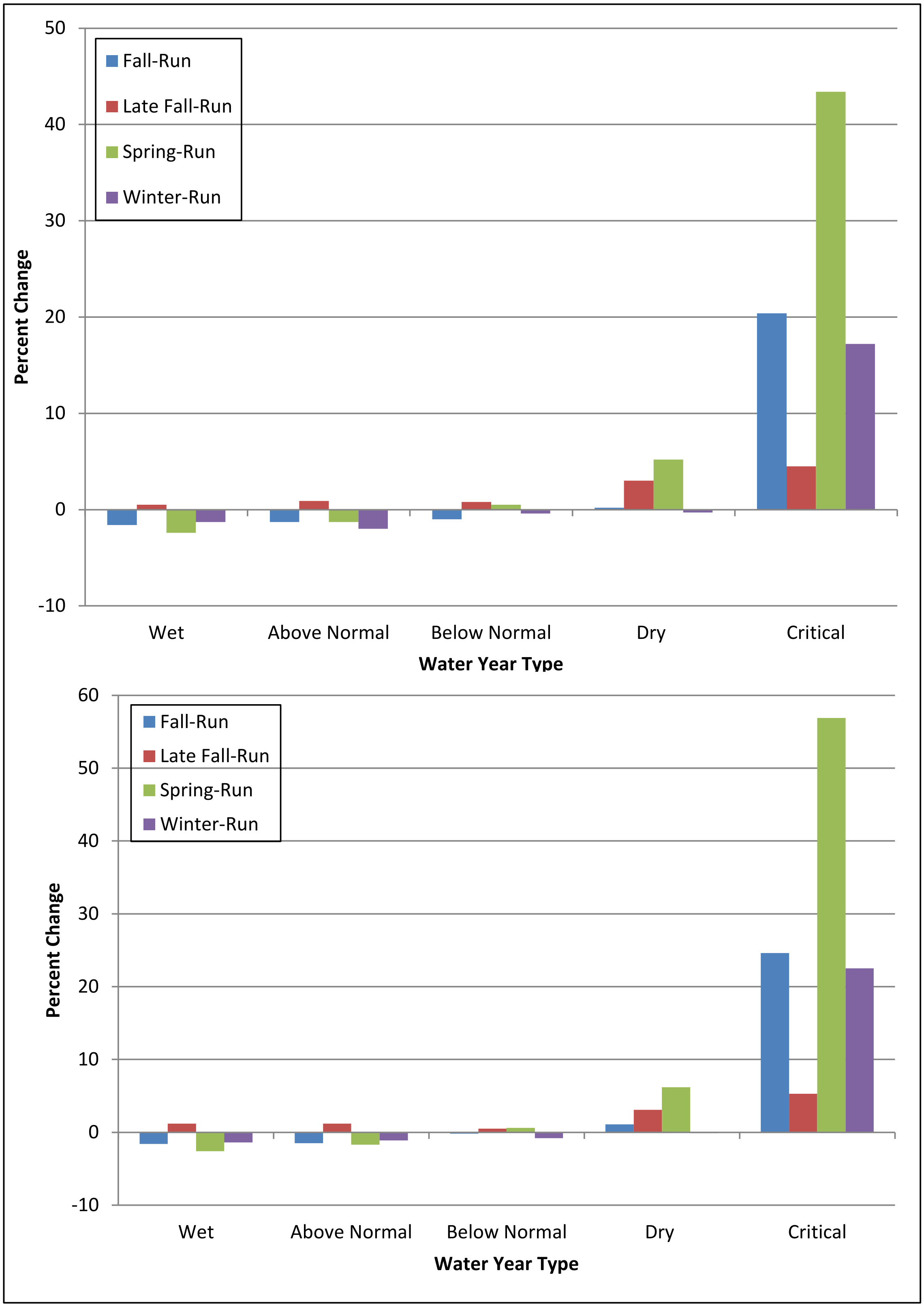
Because SALMOD indicates an insignificant change in mortality and production index for late fall-run Chinook salmon, late fall-run Chinook salmon and steelhead (as represented by their surrogate late fall-run Chinook salmon) would experience less-than-significant impacts from actions taken in CP4 and CP4A. Additionally, late fall-run Chinook salmon and steelhead would benefit from the downstream restoration program, although this was not modeled with SALMOD. Mitigation for this impact is not needed, and thus not proposed.

All Chinook Runs Combined

As with CP3, the raise for both CP4 and CP4A would increase the full pool depth by 20.5 feet and enlarge total reservoir storage capacity by 634,000 acre-feet. The additional storage created by the dam raise would be used to improve the ability to meet water temperature objectives and habitat requirements for anadromous fish during drought years (Figures 11-42 and 11-43) and increase water supply reliability. Of the increased reservoir storage space, about 378,000 acre-feet would be dedicated to increasing the supply of cold water for anadromous fish survival in CP4; 191,000 acre-feet would be dedicated in CP4A.

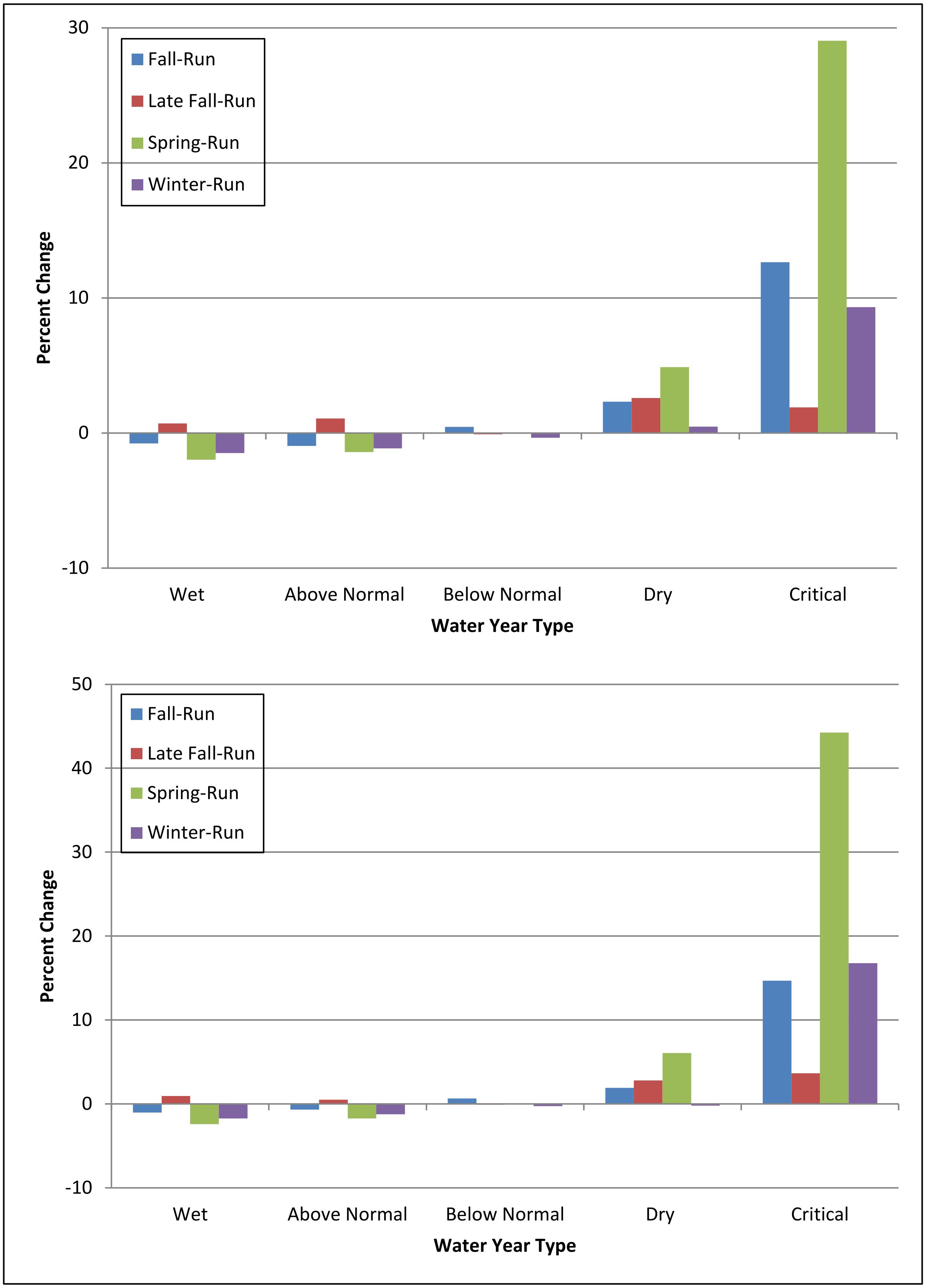
Under CP4 for the 2030 conditions, overall production for all four runs of Chinook salmon combined would increase by nearly 813,000 immature smolts migrating below RDPP. Under the CP4 2005 conditions, overall production for all four runs of Chinook salmon combined would increase by almost 1,129,000 immature smolts migrating below RDPP.

Under CP4A for the 2030 conditions, overall production for all four runs of Chinook salmon combined would increase by over 710,000 immature smolts migrating below RDPP. Under the CP4A 2005 conditions, overall production for all four runs of Chinook salmon combined would increase by almost 815,000 immature smolts migrating below RDPP.



Note: Changes in outmigrating Chinook salmon simulated using SALMOD; Water Year Types based on the Sacramento Valley Water Year Hydrologic Classification

Figure 11-42. Percent Change in Production of Chinook Salmon for CP4 Compared to the No-Action Alternative (top) and Existing Conditions (bottom)



Note: Changes in outmigrating Chinook salmon simulated using SALMOD; Water Year Types Based on the Sacramento Valley Water Year Hydrologic Classification

Figure 11-43. Percent Change in Production of Chinook Salmon for CP4A Compared to the No-Action Alternative and Existing Conditions

Impact Aqua-13 (CP4 or CP4A): Changes in Flow and Water Temperature in the Upper Sacramento River Resulting from Project Operation – Steelhead, Green Sturgeon, Sacramento Splittail, American Shad, and Striped Bass CP4 and CP4A operations generally would result in slightly improved flow and water temperature conditions in the upper Sacramento River for steelhead, green sturgeon, Sacramento splittail, American shad, and striped bass. Overall, potential flow changes resulting from the implementation of CP4 or CP4A would not be of sufficient frequency or magnitude to beneficially or adversely affect these species. However, potential water temperature changes (reductions) resulting from the implementation of CP4 or CP4A would result in beneficial effects on steelhead, green sturgeon, Sacramento splittail, American shad, and striped bass in the river, especially during critical water years. Flow- and water temperature–related effects on these fish species would be less than significant (flow) and beneficial (water temperature) relative to the Existing Condition and No-Action Alternative for both CP4 and CP4A. The benefits of the water temperature decrease outweigh the minimal effects of flow changes. Therefore, this impact would be beneficial for both CP4 and CP4A.

For CP4, this impact would be similar to Impact Aqua-13 (CP1). However, during certain years, the impact could be greater (beneficial) under CP4 than under CP1 because of the increased reservoir capacity associated with an 18.5-foot raise compared to a 6.5-foot raise, and because of the additional volume of cold water that would be available for anadromous fish.

For CP4A, this impact would be similar to Impact Aqua-13 (CP2). However, during certain years, the impact could be greater (beneficial) under CP4A than under CP2 because of the increased reservoir capacity associated with an 18.5-foot raise compared to a 12.5-foot raise, and because of the additional volume of cold water that would be available for anadromous fish.

Flow-Related Effects As under CP1, monthly mean flows at all modeling locations along the upper Sacramento River (below Shasta Dam, below Keswick Dam, above Bend Bridge, and above RBPP) under CP4 would be similar to (generally less than 4-percent difference from) flows under the Existing Condition and No-Action Alternative simulated for all months. (See the Modeling Appendix for complete modeling results.)

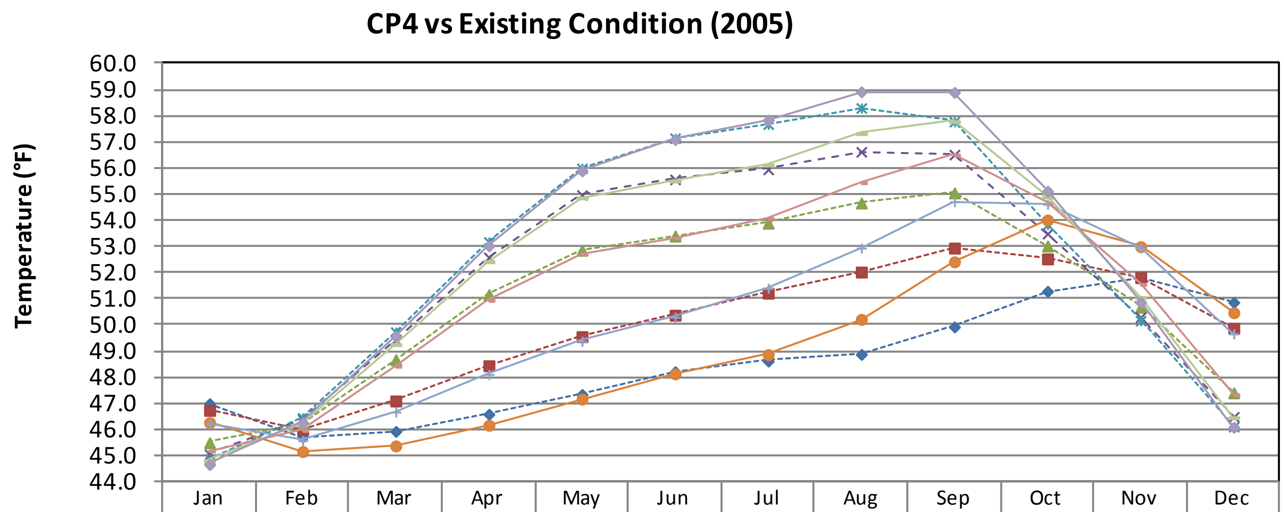
As under CP2, monthly mean flows at all modeling locations along the upper Sacramento River (below Shasta Dam, below Keswick Dam, above Bend Bridge, and above RBPP) under CP4A would be similar to (generally less than 2-percent difference from) flows under the Existing Condition and No-Action Alternative simulated for all months. (See the Modeling Appendix for complete modeling results.)

Potential flow-related effects of CP4 or CP4A on fish species of management concern in the upper Sacramento River would be minimal. Potential changes in flows and stages would diminish rapidly downstream from RBPP because of increased effects from tributary inflows, diversions, and flood bypasses.

Changes in monthly mean flows under CP4 or CP4A relative to the Existing Condition and No-Action Alternative would have no discernible effects on steelhead, green sturgeon, Sacramento splittail, American shad, or striped bass in the upper Sacramento River. Functional flows for migration, attraction, spawning, egg incubation, and rearing/emigration for these species would be unchanged. Therefore, flow-related effects on these fish species would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Water Temperature–Related Effects Changes in monthly mean water temperatures at all modeling locations along the upper Sacramento River (below Shasta Dam, below Keswick Dam, Balls Ferry, above Bend Bridge, and above RBPP) under CP4 would change fractionally when compared to water temperatures under the Existing Condition and No-Action Alternative for all months simulated (Figures 11-44 and 11-45; see the Modeling Appendix for complete modeling results).

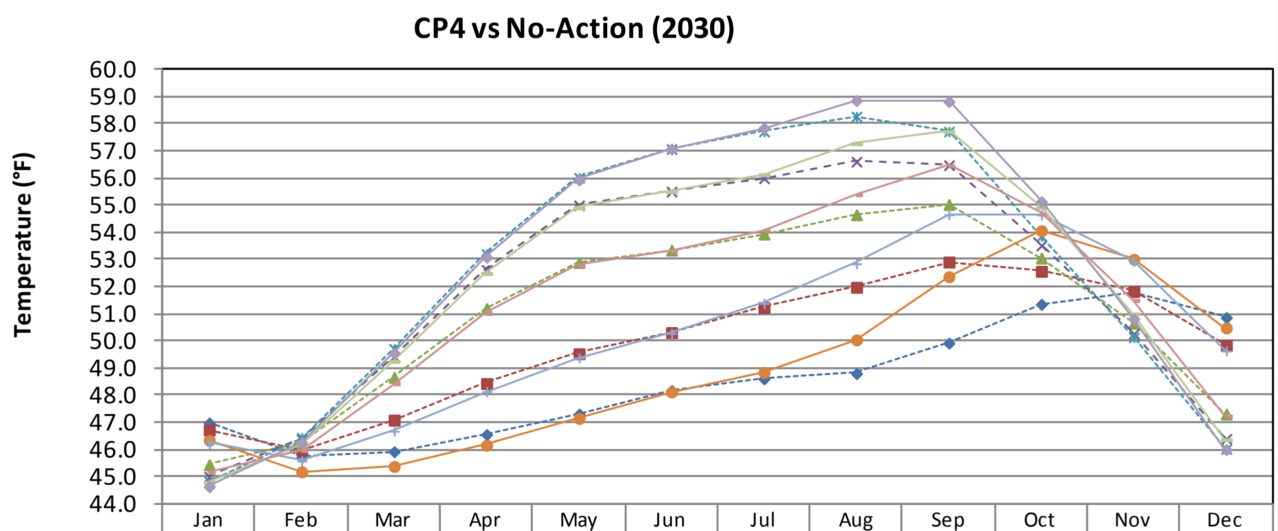
Monthly mean water temperatures at all modeling locations along the upper Sacramento River (below Shasta Dam, below Keswick Dam, Balls Ferry, above Bend Bridge, and above RBPP) under CP4A would change fractionally when compared to water temperatures under the Existing Condition and No-Action Alternative for all months simulated (Figures 11-46 and 11-47; see the Modeling Appendix for complete modeling results).



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CP4 Below Shasta	47.0	45.7	45.9	46.6	47.3	48.2	48.6	48.9	49.9	51.3	51.8	50.9
CP4 Below Keswick	46.7	46.0	47.1	48.4	49.6	50.4	51.2	52.0	52.9	52.5	51.8	49.9
CP4 Balls Ferry	45.5	46.2	48.7	51.2	52.9	53.4	53.9	54.7	55.1	53.0	50.7	47.4
CP4 Bend Bridge	45.1	46.4	49.4	52.6	55.0	55.6	56.0	56.6	56.5	53.5	50.3	46.5
CP4 RBPP	44.9	46.4	49.7	53.2	56.0	57.1	57.7	58.3	57.8	53.8	50.2	46.1
EC Below Shasta	46.3	45.2	45.4	46.2	47.2	48.1	48.9	50.2	52.4	54.0	53.0	50.5
EC Below Keswick	46.2	45.6	46.7	48.1	49.4	50.3	51.4	52.9	54.7	54.6	52.9	49.7
EC Balls Ferry	45.2	46.0	48.4	50.9	52.7	53.3	54.1	55.4	56.5	54.7	51.6	47.3
EC Bend Bridge	44.8	46.2	49.3	52.4	54.9	55.5	56.1	57.3	57.8	54.9	51.1	46.5
EC RBPP	44.7	46.3	49.6	53.0	55.9	57.1	57.8	58.9	58.9	55.1	50.9	46.1

Key: °F = degrees Fahrenheit   EC = Existing Condition
CP = Comprehensive Plan   RBPP = Red Bluff Pumping Plant

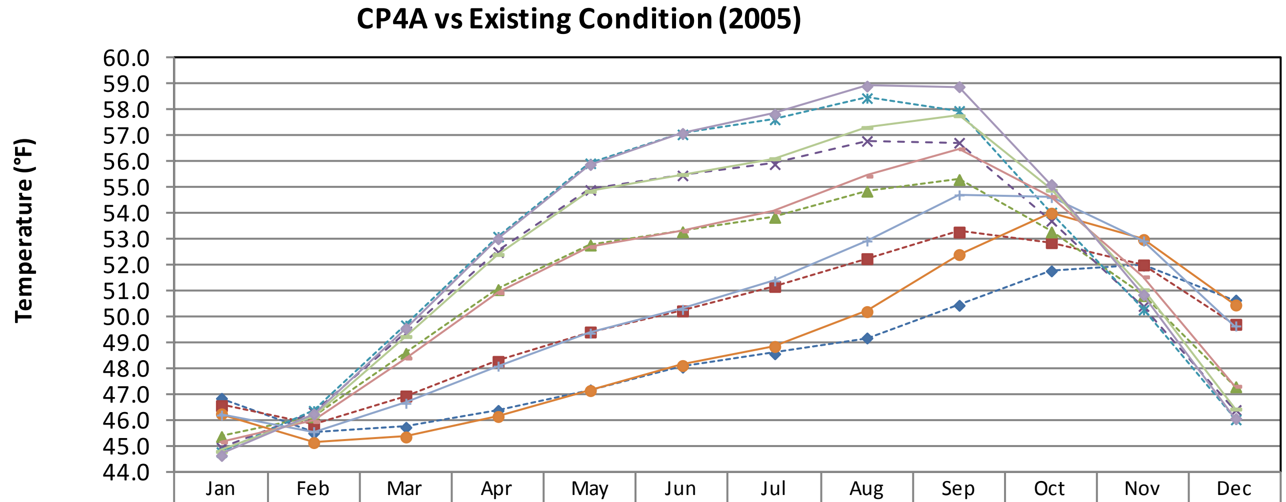
Figure 11-44. Changes in Mean Monthly Water Temperature at Modeled Locations in the Sacramento River Within the Primary Study Area (CP4 Versus Existing Condition)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CP4 Below Shasta	47.0	45.7	45.9	46.6	47.3	48.2	48.6	48.8	49.9	51.4	51.8	50.9
CP4 Below Keswick	46.7	46.0	47.1	48.4	49.5	50.3	51.2	52.0	52.9	52.6	51.8	49.8
CP4 Balls Ferry	45.5	46.2	48.7	51.2	52.9	53.4	53.9	54.7	55.0	53.1	50.7	47.3
CP4 Bend Bridge	45.0	46.4	49.4	52.6	55.0	55.5	56.0	56.6	56.5	53.5	50.3	46.4
CP4 RBPP	44.8	46.4	49.7	53.2	56.0	57.1	57.7	58.3	57.7	53.9	50.1	46.0
NA Below Shasta	46.3	45.2	45.4	46.2	47.2	48.1	48.9	50.0	52.4	54.1	53.0	50.5
NA Below Keswick	46.2	45.6	46.7	48.1	49.4	50.3	51.4	52.9	54.7	54.6	52.9	49.6
NA Balls Ferry	45.2	46.0	48.4	51.0	52.8	53.3	54.1	55.4	56.5	54.7	51.5	47.3
NA Bend Bridge	44.8	46.2	49.3	52.5	54.9	55.5	56.1	57.3	57.7	54.9	51.0	46.4
NA RBPP	44.6	46.3	49.6	53.1	55.9	57.1	57.8	58.9	58.8	55.1	50.8	46.0

Key: °F = degrees Fahrenheit   NA = No-Action
CP = Comprehensive Plan   RBPP = Red Bluff Pumping Plant

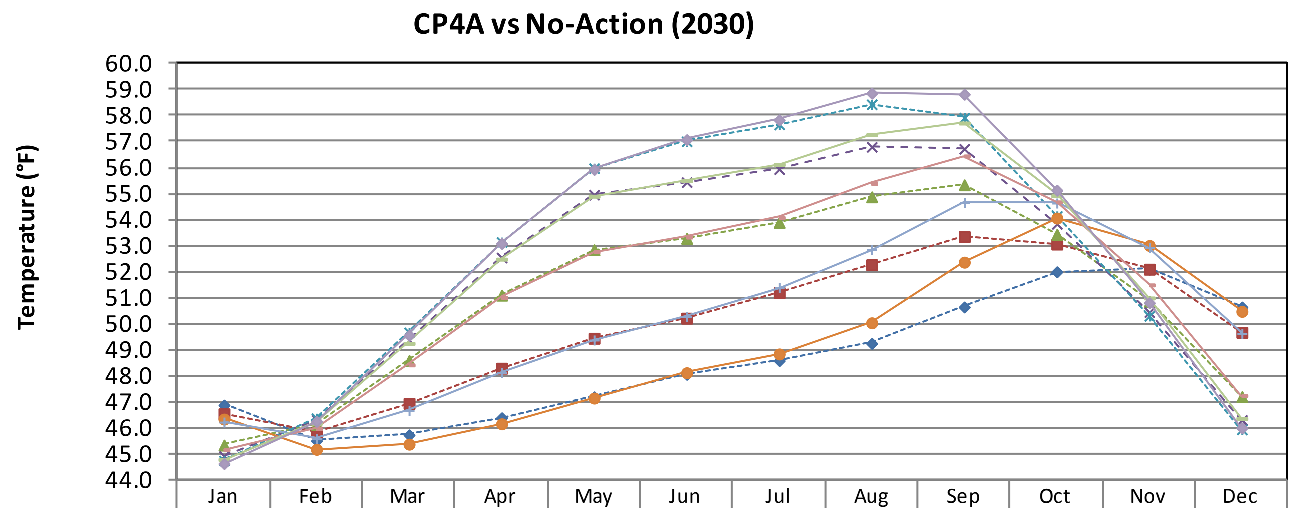
Figure 11-45. Changes in Mean Monthly Water Temperature at Modeled Locations in the Sacramento River Within the Primary Study Area (CP4 Versus No-Action Alternative)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CP4A Below Shasta	46.9	45.5	45.7	46.4	47.2	48.1	48.6	49.2	50.5	51.8	52.0	50.7
CP4A Below Keswick	46.6	45.9	47.0	48.3	49.4	50.2	51.2	52.3	53.3	52.9	52.0	49.7
CP4A Balls Ferry	45.4	46.2	48.6	51.1	52.8	53.3	53.9	54.9	55.3	53.3	50.8	47.3
CP4A Bend Bridge	45.0	46.3	49.4	52.5	54.9	55.5	55.9	56.8	56.7	53.7	50.4	46.4
CP4A RBPP	44.8	46.4	49.7	53.1	55.9	57.1	57.6	58.5	58.0	54.0	50.3	46.0
EC Below Shasta	46.3	45.2	45.4	46.2	47.2	48.1	48.9	50.2	52.4	54.0	53.0	50.5
EC Below Keswick	46.2	45.6	46.7	48.1	49.4	50.3	51.4	52.9	54.7	54.6	52.9	49.7
EC Balls Ferry	45.2	46.0	48.4	50.9	52.7	53.3	54.1	55.4	56.5	54.7	51.6	47.3
EC Bend Bridge	44.8	46.2	49.3	52.4	54.9	55.5	56.1	57.3	57.8	54.9	51.1	46.5
EC RBPP	44.7	46.3	49.6	53.0	55.9	57.1	57.8	58.9	58.9	55.1	50.9	46.1

Key: °F = degrees Fahrenheit EC = Existing Condition
CP = Comprehensive Plan RBPP = Red Bluff Pumping Plant

Figure 11-46. Changes in Mean Monthly Water Temperature at Modeled Locations in the Sacramento River Within the Primary Study Area (CP4A Versus Existing Condition)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CP4A Below Shasta	46.9	45.5	45.7	46.4	47.2	48.1	48.6	49.3	50.7	52.0	52.1	50.7
CP4A Below Keswick	46.6	45.9	47.0	48.3	49.5	50.2	51.2	52.3	53.4	53.1	52.1	49.7
CP4A Balls Ferry	45.4	46.1	48.6	51.1	52.9	53.3	53.9	54.9	55.3	53.4	50.9	47.2
CP4A Bend Bridge	44.9	46.3	49.4	52.6	55.0	55.5	55.9	56.8	56.7	53.8	50.5	46.3
CP4A RBPP	44.8	46.4	49.7	53.1	56.0	57.0	57.7	58.4	57.9	54.2	50.3	46.0
NA Below Shasta	46.3	45.2	45.4	46.2	47.2	48.1	48.9	50.0	52.4	54.1	53.0	50.5
NA Below Keswick	46.2	45.6	46.7	48.1	49.4	50.3	51.4	52.9	54.7	54.6	52.9	49.6
NA Balls Ferry	45.2	46.0	48.4	51.0	52.8	53.3	54.1	55.4	56.5	54.7	51.5	47.3
NA Bend Bridge	44.8	46.2	49.3	52.5	54.9	55.5	56.1	57.3	57.7	54.9	51.0	46.4
NA RBPP	44.6	46.3	49.6	53.1	55.9	57.1	57.8	58.9	58.8	55.1	50.8	46.0

Key: °F = degrees Fahrenheit NA = No-Action
CP = Comprehensive Plan RBPP = Red Bluff Pumping Plant

Figure 11-47. Changes in Mean Monthly Water Temperature at Modeled Locations in the Sacramento River Within the Primary Study Area (CP4A Versus No-Action Alternative)

As discussed above, the modeling simulations may not fully account for real-time management of the cold-water pool and TCD (through the SRTTG) to achieve maximum cold-water benefits. Therefore, the modeled changes in water temperature are likely conservative and understated to some varying degree. Potential changes in flows and stages would diminish rapidly downstream from RBPP because of the increasing effect of tributary inflows, diversions, and flood bypasses.

The slight changes in monthly mean water temperatures under CP4 and CP4A relative to the Existing Condition and the No-Action Alternative would have very small effects on steelhead, green sturgeon, Sacramento splittail, American shad, or striped bass in the upper Sacramento River. Monthly mean water temperatures would not rise above important thermal tolerances for the species life stages relevant to the upper Sacramento River. Therefore, water temperature–related effects on these fish species would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Aqua-14 (CP4 or CP4A): Reduction in Ecologically Important Geomorphic Processes in the Upper Sacramento River Resulting from Reduced Frequency and Magnitude of Intermediate to High Flows Project operations could cause a reduction in the magnitude, duration, or frequency of intermediate to large flows both in the upper Sacramento River and in the lowermost (confluence) areas of tributaries. Such flows are necessary for channel forming and maintenance, meander migration, and the creation of seasonally inundated floodplains. These geomorphic processes are ecologically important because they are needed to maintain important aquatic habitat functions and values for fish and macroinvertebrate communities. This impact would be potentially significant.

This impact would be similar to Impact Aqua-14 (CP1) for CP4. The impact could be greater under CP4 than under CP1 because the increased reservoir capacity associated with an 18.5-foot raise compared to a 6.5-foot raise would allow for storage of additional water volume (and flows) behind the raised dam.

This impact would be similar to Impact Aqua-14 (CP2) for CP4A. The impact could be greater under CP4A than under CP2 because the increased reservoir capacity associated with an 18.5-foot raise compared to a 12.5-foot raise would allow for storage of additional water volume (and flows) behind the raised dam.

Sediment transport, deposition, and scour regulate the formation of key habitat features such as point bars, gravel deposits, and SRA habitat. Intermediate to high flows and the associated stage elevation of the river surface also provide a backwater effect on the lowermost segment of tributaries, reducing the potential for downcutting. These processes are regulated by the magnitude and frequency of flow. Relatively large floods provide the energy required to mobilize sediment from the riverbed, produce meander migration, increase stage elevation, and create seasonally inundated floodplains. Operations under CP4 or

CP4A could result in a reduction in the intermediate to large flows necessary for channel forming and maintenance, meander migration, and creation of seasonally inundated floodplains.

Implementation of CP4 or CP4A would cause a further reduction in the magnitude, duration, and frequency of intermediate to large flows, relative to the Existing Condition and No-Action Alternative. Overall, the project would increase the existing, ongoing effects on geomorphic processes resulting from the operation of Shasta Dam that are necessary for channel forming and maintenance, meander migration, and the creation of seasonally inundated floodplains. These effects would likely occur throughout the upper Sacramento River portion of the primary study area.

As discussed above, CP4 and CP4A both include a 10-year gravel augmentation program and the restoration of riparian, floodplain, and side-channel habitat at up to six potential restoration sites as additional environmental commitments. Placing gravel along the Sacramento River channel and bank annually and restoring riparian, floodplain, and side-channel habitat at up to six sites would result in benefits to ecological processes (e.g., sediment transport and deposition, floodplain inundation) that would partially offset the effects described above. Nevertheless, reductions in the magnitude of high flows would likely be sufficient to reduce ecologically important processes along the upper Sacramento River.

This impact would be potentially significant for CP4. Mitigation for this impact is proposed in Section 11.3.4, "Mitigation Measures."

This impact would be potentially significant for CP4A. Mitigation for this impact is identical to that proposed for CP4 in Section 11.3.4, "Mitigation Measures."

Lower Sacramento River and Delta

Impact Aqua-15 (CP4 or CP4A): Changes in Flow and Water Temperatures in the Lower Sacramento River and Tributaries and Trinity River Resulting from Project Operation – Fish Species of Primary Management Concern Project operation would result in no discernible change in monthly mean flows or water temperature conditions in the lower Sacramento River. However, predicted changes in flows in the Feather, American, and Trinity rivers could result in adverse effects on Chinook salmon, steelhead, Coho salmon, green sturgeon, Sacramento splittail, American shad, and striped bass. This impact would be potentially significant for both CP4 and CP4A.

This impact would be similar to Impact Aqua-15 (CP1) for CP4. The impact could be greater under CP4 than under CP1 because the increased reservoir capacity associated with an 18.5-foot raise compared to a 6.5-foot raise would allow for storage of additional water volume (and increased cold-water pool) behind the raised dam.

This impact would be similar to Impact Aqua-15 (CP2) for CP4A. The impact could be greater under CP4A than under CP2 because the increased reservoir capacity associated with an 18.5-foot raise compared to a 12.5-foot raise would allow for storage of additional water volume (and increased cold water pool) behind the raised dam.

As described below, mean monthly flows at various modeling locations on the lower Sacramento River and tributaries under CP4 and CP4A were compared with mean monthly flows simulated for Existing Conditions and No-Action Alternative conditions. See the Modeling Appendix for complete CalSim-II modeling results.

Lower Sacramento River As under CP1, monthly mean flows at the lower Sacramento River modeling locations under CP4 or CP4A would be essentially equivalent to flows under the Existing Condition and No-Action Alternative simulated for all months. Differences in monthly mean flow were generally small (less than 2 percent) and within the existing range of variability. Potential changes in flows would diminish rapidly downstream from RBPP because of the increasing effect from tributary inflows, diversions, and flood bypasses. Similarly, potential changes in water temperatures in the lower Sacramento River caused by small changes in releases would diminish rapidly downstream because of the increasing effects of inflows, atmospheric influences, and groundwater. Therefore, flow- and temperature-related impacts on fish species in the lower Sacramento River would be less than significant for CP4 or CP4A. Mitigation for this impact is not needed, and thus not proposed.

As under CP1, the effects of altered flow regimes resulting from implementation of CP4 or CP4A are unlikely to extend into the lower Sacramento River and Delta because the Central Valley's reservoirs and diversions are managed as a single integrated system (consisting of the SWP and the CVP). The operational requirements, including the 2008 USFWS BO and the 2009 NMFS BO, have been designed to maintain standards for flow to the lower Sacramento River and Delta. CVP and SWP operations must be consistent with these ESA BOs. Thus, implementation of CP4 would not likely alter flow to the Delta or water temperatures in the lower Sacramento River and primary tributaries within the extended study area to a degree sufficient to cause discernible effects on Chinook salmon, steelhead, green sturgeon, Sacramento splittail, American shad, or striped bass relative to the Existing Condition and No-Action Alternative. Functional flows for fish migration, attraction, spawning, egg incubation, and rearing/emigration for all these fish species would be unchanged. Therefore, flow- and water temperature–related effects on these fish species would be less than significant for CP4 or CP4A. Mitigation for this impact is not needed, and thus not proposed.

Lower Feather River, American River, and Trinity River Also, as under CP1, monthly mean flows at all modeling locations on the lower Feather River, the American River, and the Trinity River under CP4 or CP4A would be essentially equivalent to (less than 2-percent difference from) flows under the Existing Condition and No-Action Alternative simulated for most months. However, simulations for several months within the modeling record show substantial changes to flows in tributaries. Potential changes in flows could be reduced by real-time operations to meet existing rules and because of operation of upstream reservoirs (Lake Oroville, Folsom Lake, and Trinity Lake) and increasing effects from tributary inflows, diversions, and flood bypasses. Potential changes in water temperatures in the Feather and American rivers caused by altered releases from reservoirs could diminish downstream because of the increasing effect of inflows, and atmospheric and groundwater influences. Nevertheless, based on predicted changes in flow and associated flow-habitat relationships, potential flow-related impacts on species of management concern in the American, Feather, and Trinity rivers could occur.

This impact would be potentially significant for CP4. Mitigation for this impact is proposed in Section 11.3.4, "Mitigation Measures."

This impact would be potentially significant for CP4A. Mitigation for this impact is identical to that proposed for CP4 in Section 11.3.4, "Mitigation Measures."

Impact Aqua-16 (CP4 or CP4A): Reduction in Ecologically Important Geomorphic Processes in the Lower Sacramento River Resulting from Reduced Frequency and Magnitude of Intermediate to High Flows Project operation could cause a reduction in intermediate to large flows both in the lower Sacramento River and in the lowermost (confluence) areas of tributaries. Such flows are necessary for channel forming and maintenance, meander migration, and the creation of seasonally inundated floodplains. These geomorphic processes are ecologically important because they are needed to maintain important aquatic habitat functions and values for fish and macroinvertebrate communities. This impact would be potentially significant.

This impact would be similar to Impact Aqua-16 (CP1) for CP4 and CP4A. The impact could be greater under CP4 than under CP1 because the increased reservoir capacity associated with an 18.5-foot raise compared to a 6.5-foot raise would allow for storage of additional water volume (and flows) behind the raised dam.

Sediment transport, deposition, and scour regulate the formation of key habitat features such as point bars, gravel deposits, and SRA habitat. Intermediate to high flows and the associated stage elevation of the river surface also provide a backwater effect on the lowermost segment of tributaries, which reduces the potential for downcutting. These processes are regulated by the magnitude and frequency of flows. Relatively large floods provide the energy required to mobilize sediment from the bed, produce meander migration, increase stage elevation, create seasonally inundated floodplains, and inundate floodplain bypasses. Operations under CP4 or CP4A could result in reduced intermediate to large flows that are necessary for channel forming and maintenance, meander migration, and the creation of seasonally inundated floodplains.

Implementation of CP4 or CP4A would cause a further reduction in the magnitude, duration, and frequency of intermediate to large flows, relative to the Existing Condition and No-Action Alternative. Overall, the project would increase the existing, ongoing impacts on geomorphic processes resulting from the operation of Shasta Dam that are necessary for channel forming and maintenance, meander migration, the creation of seasonally inundated floodplains, and the inundation of floodplain bypasses. These effects would likely occur along the upper reaches of the lower Sacramento River.

Reductions in the magnitude of high flows would likely be sufficient to reduce ecologically important processes along the upper Sacramento River and its floodplain bypasses.

This impact would be potentially significant for CP4. Mitigation for this impact is proposed in Section 11.3.4, “Mitigation Measures.”

This impact would be potentially significant for CP4A. Mitigation for this impact is identical to that proposed for CP4 in Section 11.3.4, “Mitigation Measures.”

Impact Aqua-17 (CP4 or CP4A): Effects to Delta Fisheries Resulting from Changes to Delta Outflow Delta outflow conditions under CP4 would be the same as those under CP1, and would result in changes to average monthly Delta outflow of less than 5 percent in all water year types (with the exception of December of critical years under 2005 conditions), as shown in Table 11-12. This impact on Delta fisheries and hydrologic transport processes within the Bay-Delta for CP4 would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Delta outflow conditions under CP4A would be the same as those under CP2, and would result in changes to average monthly Delta outflow of less than 5 percent in all water year types (with the exception of December of critical years under 2005 conditions), as shown in Table 11-23. This impact on Delta fisheries and hydrologic transport processes within the Bay-Delta for CP4A would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Aqua-18 (CP4 or CP4A): Effects to Delta Fisheries Resulting from Changes to Delta Inflow Delta inflow conditions under CP4 would be the same as those under CP1, and would not decrease average monthly Delta inflow by 5 percent or more in any year type, as shown in Table 11-13. This impact on

Delta fisheries and hydrologic transport processes within the Bay-Delta would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

Delta inflow conditions under CP4A would be the same as those under CP2, and would not decrease average monthly Delta inflow by 5 percent or more in any year type, as shown in Table 11-24. This impact on Delta fisheries and hydrologic transport processes within the Bay-Delta would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact Aqua-19 (CP4 or CP4A): Effects to Delta Fisheries Resulting from Changes in Sacramento River Inflow CP4 operations would be the same as those under CP1 and would result in a variable response in Sacramento River flow, in turn, resulting in both increases and decreases in river flow above the Existing Condition and No-Action Alternative depending on month and water year type. Decreases in Sacramento River inflow would not equal or exceed 5 percent, as shown in Table 11-14. This impact would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

CP4A operations would be the same as those under CP2 and would result in a variable response in Sacramento River flow, in turn, resulting in both increases and decreases in river flow above the Existing Condition and No-Action Alternative depending on month and water year type. Decreases in Sacramento River inflow would not equal or exceed 5 percent, as shown in Table 11-25. This impact would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact Aqua-20 (CP4 or CP4A): Effects to Delta Fisheries Resulting from Changes in San Joaquin River Flow at Vernalis CP4 operation would be the same as under CP1 and would result in no discernible change in San Joaquin River flows at Vernalis, as shown in Table 11-15. Therefore, CP4 would have no effect on Delta fisheries or transport mechanisms within the lower San Joaquin River and Delta relative to either the No-Action Alternative of Existing Condition. There would be no impact for CP4. Mitigation for this impact is not needed, and thus not proposed.

CP4A operation would be the same as under CP2 and would result in no discernible change in San Joaquin River flows at Vernalis, as shown in Table 11-26. Therefore, CP4A would have no effect on Delta fisheries or transport mechanisms within the lower San Joaquin River and Delta relative to either the No-Action Alternative of Existing Condition. There would be no impact for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact Aqua-21 (CP4 or CP4A): Reduction in Low-Salinity Habitat Conditions Resulting from an Upstream Shift in X2 Location CP4 operations would be the same as CP1 operations, and would result in a less than 0.5 km movement upstream or downstream from the X2 location from its location under the Existing Condition or No-Action Alternative, and thus cause minimal reduction in low-salinity habitats, as shown in Table 11-16. This impact would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

CP4A operations would be the same as CP2 operations, and would result in a less than 0.5 km movement upstream or downstream from the X2 location from its location under the Existing Condition or No-Action Alternative, and thus cause minimal reduction in low-salinity habitats, as shown in Table 11-27. This impact would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact Aqua-22 (CP4 or CP4A): Increase in Mortality of Species of Primary Management Concern as a Result of Increased Reverse Flows in Old and Middle Rivers CP4 operations would be the same as CP1 operations, and would result in minimal changes to reverse flows in Old and Middle rivers, as shown in Table 11-17. The increases in reverse flows would be expected to contribute to a small increase in the vulnerability of Chinook salmon, delta smelt, striped bass, threadfin shad, and other resident warm-water fish to increased salvage and potential losses.

CP4A operations would be the same as CP2 operations, and would result in minimal changes to reverse flows in Old and Middle rivers, as shown in Table 11-28. The increases in reverse flows would be expected to contribute to a small increase in the vulnerability of Chinook salmon, delta smelt, striped bass, threadfin shad, and other resident warm-water fish to increased salvage and potential losses.

This impact would be less than significant for CP4 or CP4A for striped bass, threadfin shad, and other resident warm-water fish, and potentially significant for delta smelt and Chinook salmon. Overall, the impact for CP4 and CP4A would be potentially significant. Mitigation for this impact is not proposed because operations will be guided by RPAs established by NMFS and USFWS BOs to reduce any impacts to listed fish species, thus reducing effects to non-listed fish species as well.

Impact Aqua-23 (CP4 or CP4A): Increase in the Risk of Entrainment or Salvage of Species of Primary Management Concern at CVP and SWP Export Facilities Due to Changes in CVP and SWP Exports CP4 operations would be the same as CP1 operations, and may result in an increase of CVP and SWP exports, which is assumed to result in a direct proportional increase or decrease in the risk of fish being entrained and salvaged at the facilities, as shown in Table 11-18.

CP4A operations would be the same as CP2 operations, and may result in an increase of CVP and SWP exports, which is assumed to result in a direct proportional increase or decrease in the risk of fish being entrained and salvaged at the facilities, as shown in Table 11-29.

Therefore, the resulting impact of CP4 to Chinook salmon, steelhead, longfin smelt, striped bass, and splittail would be less than significant; the resulting impact to delta smelt would be potentially significant.

Under CP4A, however, the resulting impact would be less than significant for Chinook salmon, but potentially significant for delta smelt, steelhead, longfin smelt, striped bass, and splittail. Overall, this impact would be potentially significant for CP4 or CP4A. Mitigation for this impact is not proposed because operations will be guided by RPAs established by NMFS and USFWS BOs to reduce any impacts to listed fish species.

CVP/SWP Service Areas

Impact Aqua-24 (CP4 or CP4A): Impacts on Aquatic Habitats and Fish Populations in the CVP and SWP Service Areas Resulting from Modifications to Existing Flow Regimes The implementation of CP4 or CP4A could result in modified flow regimes that would reduce the frequency and magnitude of high winter flows along the Sacramento River; however, the hydrologic effects to tributaries and reservoirs (e.g., New Melones and San Luis) with CVP and SWP dams, as well as the conveyances south of the Delta would be substantially less than impacts on the lower Sacramento River. The change in hydrology in the CVP and SWP service areas could affect aquatic habitats that provide habitat for the fish community; however, the changes would not result in substantial effects on their distribution or abundance. Therefore, this impact of CP4 or CP4A would be less than significant.

The impact of CP4 would be similar to Impact Aqua-24 (CP1). The impact of CP4A would be similar to Impact Aqua-24 (CP2).

The hydrologic effects to the CVP and SWP service areas would not result in substantial effects on the distribution or abundance of the fish species in the CVP and SWP service areas. The effects from CP4 or CP4A on CVP and SWP reservoir elevations, filling, spilling, and planned releases, and resulting downstream flows, would be small and well within the range of variability that commonly occurs in these reservoirs and downstream flows.

This impact would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

This impact would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

CP5 – 18.5-Foot Dam Raise, Combination Plan

CP5 primarily focuses on increasing water supply reliability, anadromous fish survival, Shasta Lake area environmental resources, and recreation opportunities. By raising Shasta Dam 18.5 feet, in combination with spillway modifications, CP5 would increase the height of the reservoir full pool by 20.5 feet and enlarge the total storage capacity in the reservoir by 634,000 acre-feet. The existing TCD would be extended to achieve efficient use of the expanded cold-water pool. Shasta Dam operational guidelines would continue essentially unchanged, except during dry years and critical years, when 150,000 acre-feet and 75,000 acre-feet, respectively, of the increased storage capacity in Shasta Reservoir would be reserved to specifically focus on increasing M&I deliveries. CP5 also includes constructing additional fish habitat in and along the shoreline of Shasta Lake and along the lower reaches of its tributaries; augmenting spawning gravel and restoring riparian, floodplain, and side channel habitat in the upper Sacramento River; and increasing recreation opportunities at Shasta Lake.

CP5 would help reduce future water shortages through increasing drought year and average year water supply reliability for agricultural and M&I deliveries. In addition, the increased depth and volume of the cold-water pool in Shasta Reservoir would contribute to improving seasonal water temperatures for anadromous fish in the upper Sacramento River.

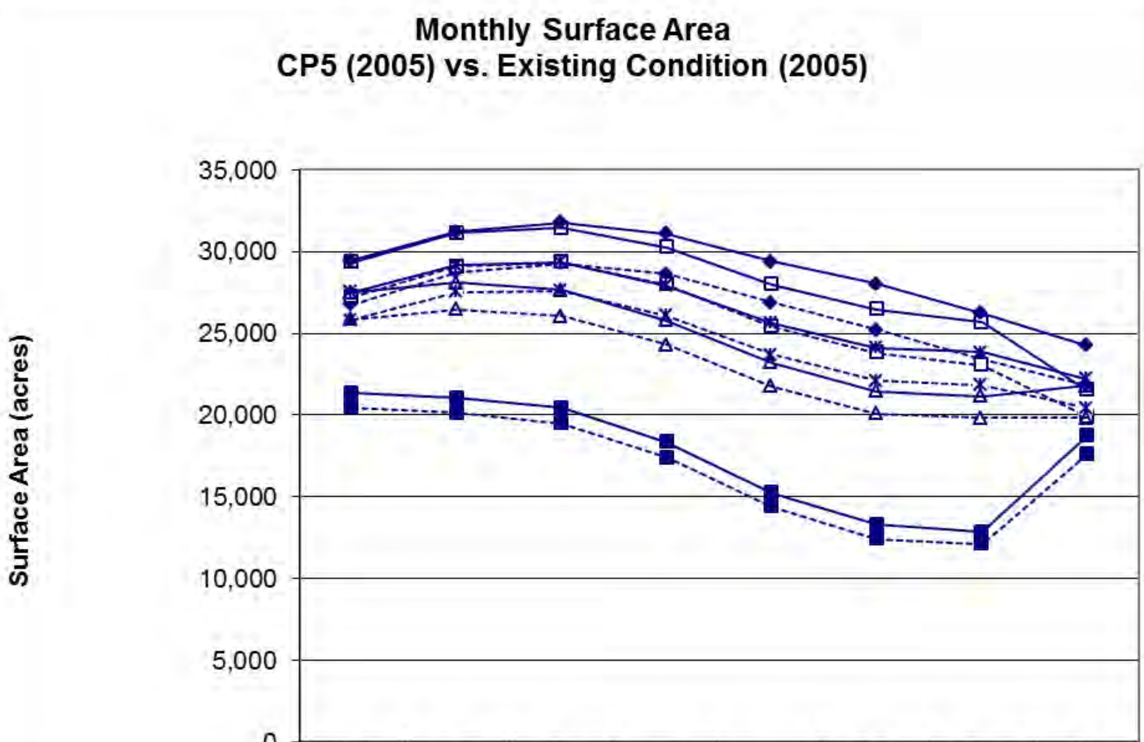
Shasta Lake and Vicinity

Impact Aqua-1 (CP5): Effects on Nearshore, Warm-Water Habitat in Shasta Lake from Project Operations Under CP5, this impact would be similar to CP3, with slightly less of an increase in warm-water fish habitat than CP3 because of differences in operations, but inclusion of nearshore fish habitat enhancement would result in a similar or greater increase than CP3. Warm-water fish habitat would be increased compared to the Existing Condition and the No-Action Alternative as measured by increased lake surface area and reductions in lake level fluctuations (Figures 11-48 through 11-51). Its impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Aqua-2 (CP5): Effects on Nearshore, Warm-Water Habitat in Shasta Lake from Project Construction This impact would be similar to Impact Aqua-2 (CP3). This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Aqua-3 (CP5): Effects on Cold-Water Habitat in Shasta Lake Under CP5, operations-related changes in the ratio of the volume of cold-water storage to surface area would increase the availability of suitable habitat for cold-water fish in Shasta Lake, including rainbow trout (Figure 11-52). This impact would be beneficial.

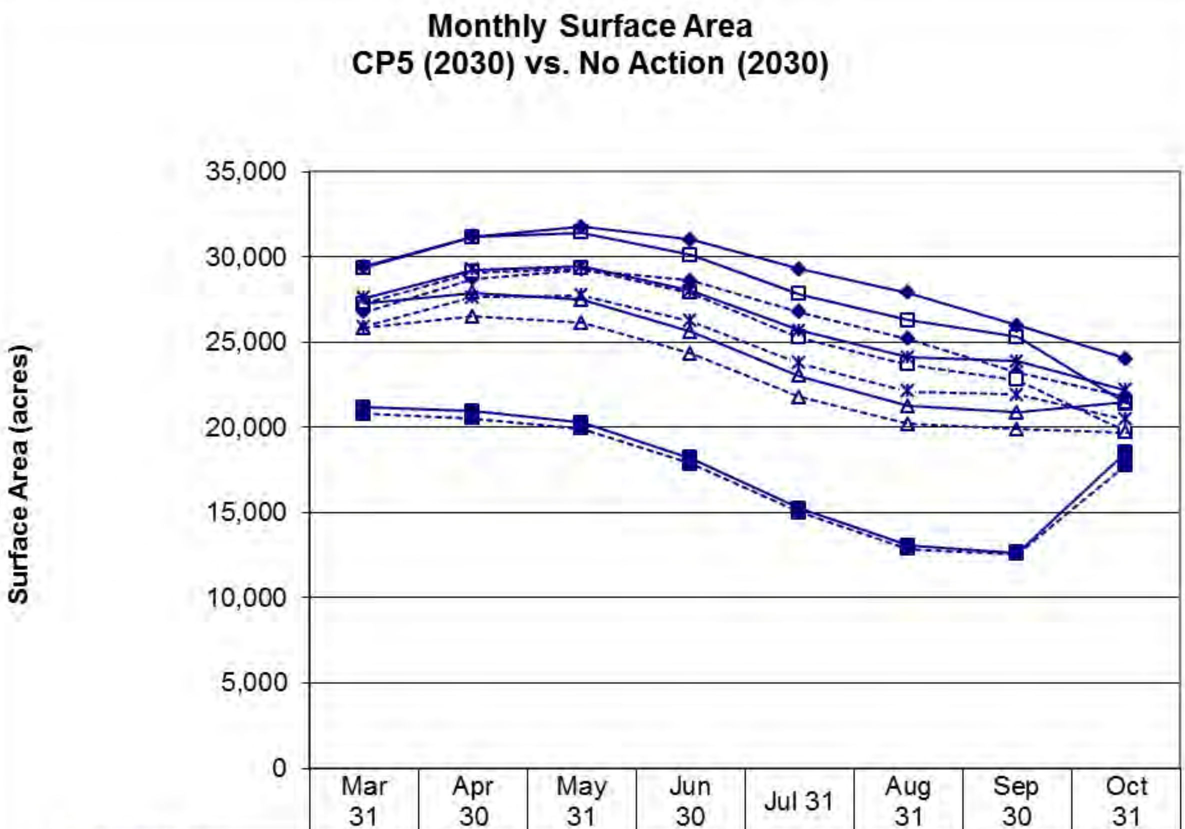
This impact would be beneficial, but slightly less than that provided under CP3. Mitigation for this impact is not needed, and thus not proposed.



	Mar 31	Apr 30	May 31	Jun 30	Jul 31	Aug 31	Sep 30	Oct 31
EC W	26,790	28,748	29,277	28,624	26,872	25,226	23,413	21,827
EC AN	27,245	29,082	29,336	27,992	25,400	23,826	23,061	19,906
EC BN	25,807	27,534	27,621	26,104	23,714	22,114	21,837	20,425
EC D	25,850	26,467	26,058	24,300	21,754	20,093	19,840	19,828
EC C	20,467	20,142	19,500	17,381	14,400	12,418	12,111	17,572
CP5 2005 W	29,448	31,208	31,794	31,081	29,404	28,018	26,222	24,264
CP5 2005 AN	29,371	31,154	31,450	30,246	27,971	26,468	25,652	21,521
CP5 2005 BN	27,525	29,160	29,355	27,921	25,627	24,124	23,836	22,213
CP5 2005 D	27,499	28,088	27,639	25,800	23,210	21,473	21,142	21,790
CP5 2005 C	21,359	21,047	20,422	18,355	15,245	13,295	12,828	18,737

Key:
AN = above-normal water
BN= below-normal water years
C = critical water years
CP = Comprehensive Plan
D = dry water years
EC = Existing Condition
W = wet water years

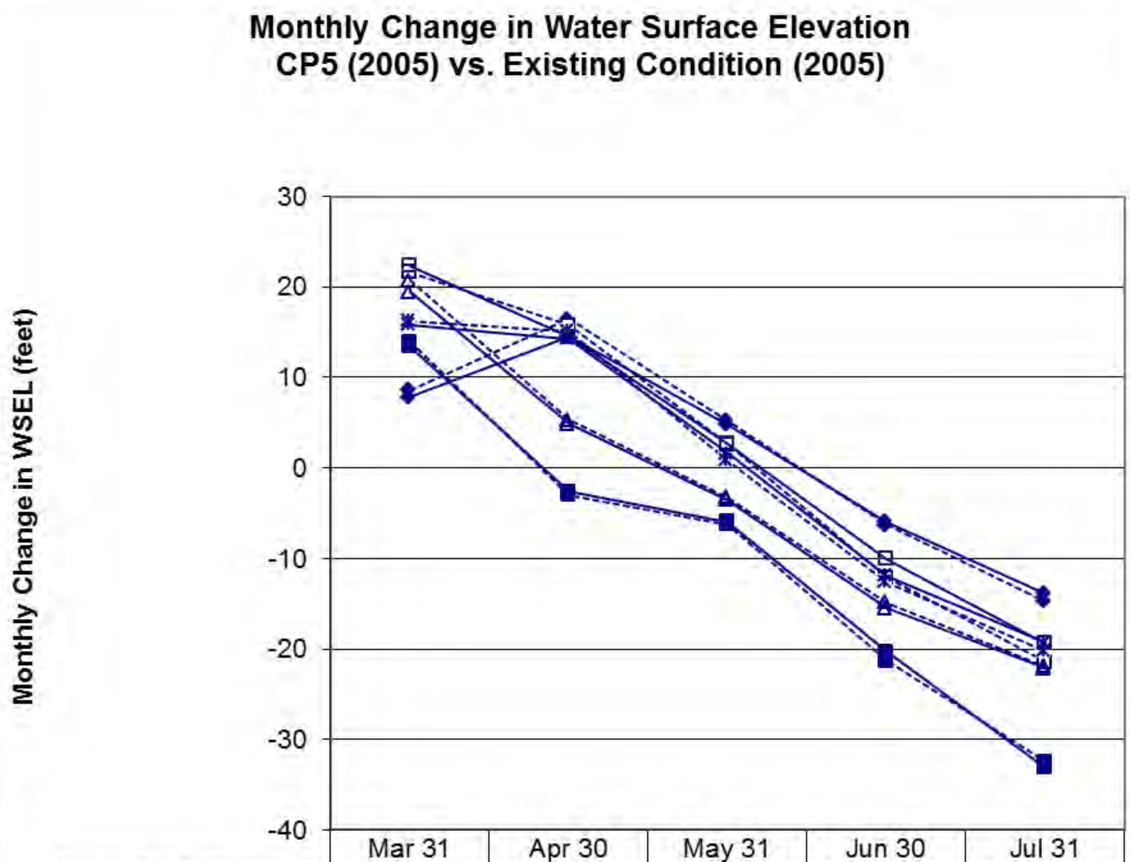
Figure 11-48. Average Monthly Surface Area for Each Water Year Type Within the Shasta Lake Vicinity of the Primary Study Area, CP5 Versus Existing Condition



	Mar 31	Apr 30	May 31	Jun 30	Jul 31	Aug 31	Sep 30	Oct 31
NA W	26,775	28,735	29,273	28,604	26,797	25,183	23,205	21,808
NA AN	27,258	29,117	29,325	27,921	25,294	23,687	22,800	19,759
NA BN	25,918	27,662	27,770	26,239	23,764	22,137	21,923	20,469
NA D	25,843	26,514	26,134	24,346	21,780	20,209	19,910	19,728
NA C	20,801	20,548	19,942	17,866	15,026	12,873	12,556	17,800
CP5 2030 W	29,435	31,196	31,789	31,040	29,305	27,909	26,001	24,052
CP5 2030 AN	29,355	31,158	31,429	30,120	27,832	26,297	25,298	21,414
CP5 2030 BN	27,600	29,249	29,439	28,012	25,678	24,121	23,875	22,176
CP5 2030 D	27,316	27,918	27,481	25,609	23,020	21,267	20,867	21,475
CP5 2030 C	21,189	20,934	20,294	18,198	15,233	13,069	12,642	18,553

Key:
AN = above-normal water
BN= below-normal water years
C = critical water years
CP = Comprehensive Plan
D = dry water years
NA = No-Action
W = wet water years

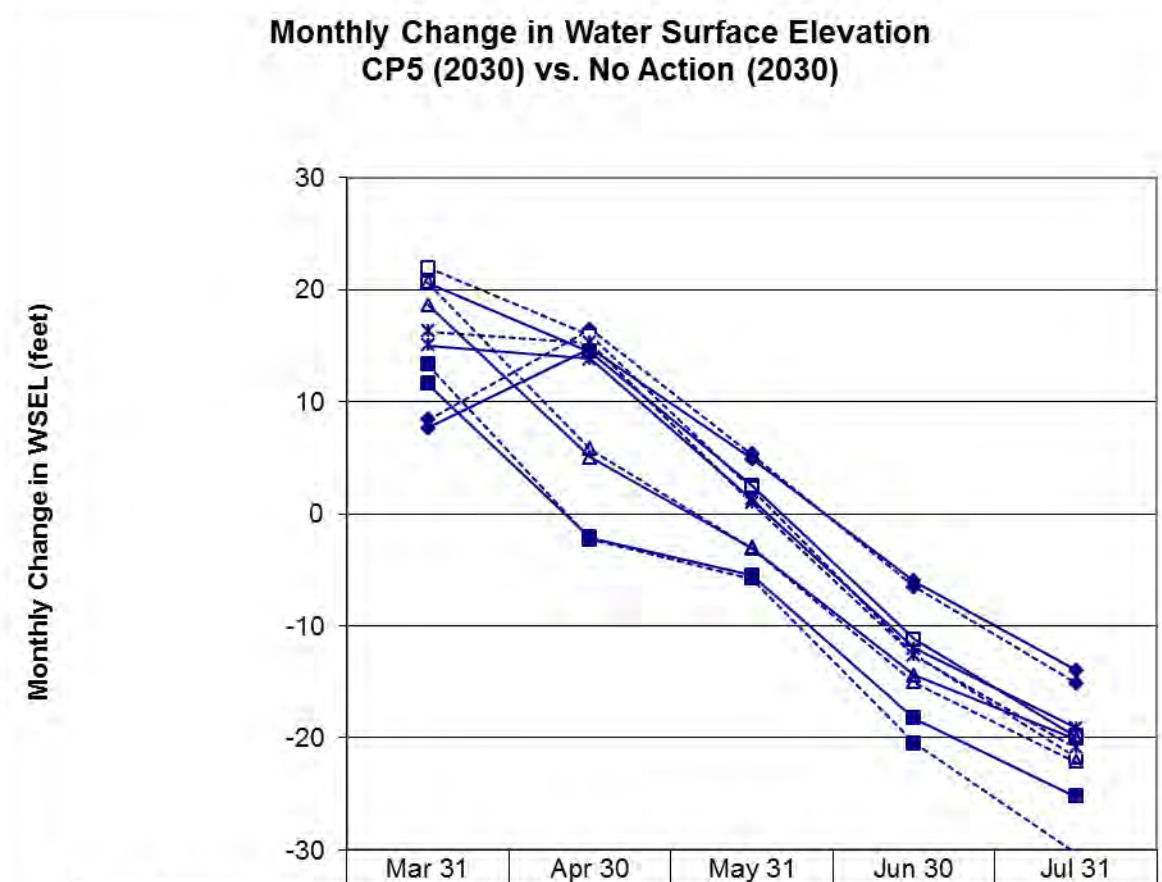
Figure 11-49. Average Monthly Surface Area for Each Water Year Type Within the Shasta Lake Vicinity of the Primary Study Area, CP5 Versus the No-Action Alternative



	Mar 31	Apr 30	May 31	Jun 30	Jul 31
EC W	9	16	5	-6	-15
EC AN	22	16	3	-12	-21
EC BN	16	15	1	-13	-20
EC D	21	5	-3	-15	-22
EC C	14	-3	-6	-21	-32
CP5 (2005) W	8	15	5	-6	-14
CP5 (2005) AN	22	15	3	-10	-19
CP5 (2004) BN	16	14	2	-12	-19
CP5 (2005) D	19	5	-4	-15	-22
CP5 (2005) C	13	-3	-6	-20	-33

Key:
AN = above-normal water
BN= below-normal water years
C = critical water years
CP = Comprehensive Plan
D = dry water years
EC = Existing Condition
W = wet water years
WSEL = water surface elevation

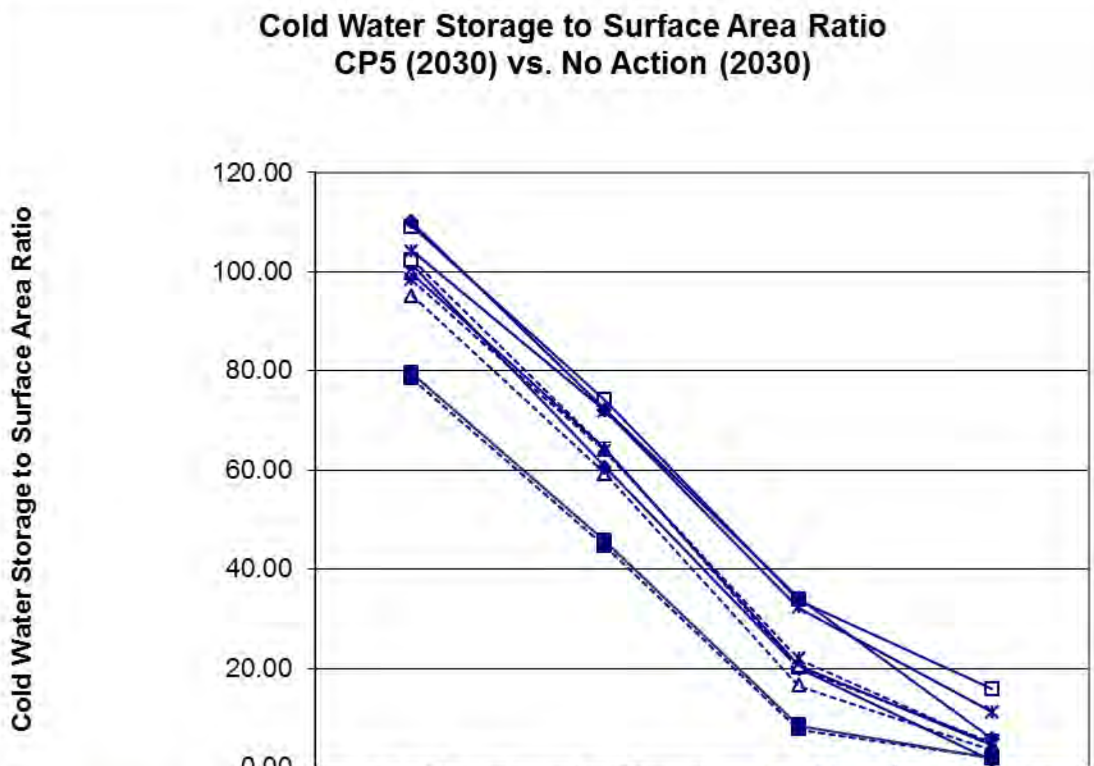
Figure 11-50. Average Monthly Change in Water Surface Elevation for Each Water Year Type Within the Shasta Lake Vicinity of the Primary Study Area, CP5 Versus the Existing Condition



	Mar 31	Apr 30	May 31	Jun 30	Jul 31
NA W	8	16	5	-7	-15
NA AN	22	16	2	-13	-22
NA BN	16	15	1	-13	-21
NA D	21	6	-3	-15	-22
NA C	13	-2	-6	-21	-30
CP4 (2030) W	8	15	5	-6	-14
CP4 (2030) AN	21	14	2	-11	-20
CP4 (2030) BN	15	14	1	-12	-19
CP4 (2030) D	19	5	-3	-14	-20
CP4 (2030) C	12	-2	-6	-18	-25

Key:
AN = above-normal water
BN= below-normal water years
C = critical water years
CP = Comprehensive Plan
D = dry water years
NA = No-Action
W = wet water years
WSEL = water surface elevation

Figure 11-51. Average Monthly Change in Water Surface Elevation for Each Water Year Type Within the Shasta Lake Vicinity of the Primary Study Area, CP5 Versus the No-Action Alternative



	Apr 30	Jun 30	Aug 31	Oct 31
NA W	101.33	60.49	19.89	1.43
NA AN	102.30	64.04	20.12	5.09
NA BN	98.27	63.71	21.84	4.64
NA D	95.13	59.14	16.50	3.38
NA C	78.43	44.58	7.66	1.82
CP5 2030 W	109.95	72.09	34.16	5.78
CP5 2030 AN	109.05	74.02	33.71	15.89
CP5 2030 BN	104.10	71.89	32.26	11.23
CP5 2030 D	99.54	64.08	20.51	4.45
CP5 2030 C	79.50	45.61	8.44	1.91

Key:
AN = above-normal water
BN= below-normal water years
C = critical water years
CP = Comprehensive Plan
D = dry water years
NA = No-Action
W = wet water years

Figure 11-52. Average Monthly Cold-water Storage to Surface Area Ratio for Each Water Year Type Within the Shasta Lake Vicinity of the Primary Study Area, CP5 Versus the No-Action Alternative

Impact Aqua-4 (CP5): Effects on Special-Status Aquatic Mollusks Under CP5, habitat for special-status mollusks could be inundated. Seasonal fluctuations in the surface area and WSEL of Shasta Lake could adversely affect special-status aquatic mollusks that could occupy habitat in or near Shasta Lake and its tributaries. This impact would be similar to Impact Aqua-4 (CP3, CP4, and CP4A).

Except for the California floater, the occurrence of special-status mollusks in Shasta Lake and the lower reaches of its tributaries is unlikely. Modification or loss of suitable habitat for California floater would occur through increased WSEL and seasonal fluctuations in the surface area under CP5.

Therefore, this impact would be potentially significant. Mitigation for this impact is proposed in Section 11.3.4, "Mitigation Measures."

Impact Aqua-5 (CP5): Effects on Special-Status Fish Species Similar to CP3, CP4, and CP4A, the expansion of the surface area of Shasta Lake and inundation of additional tributary habitat, including inundation of fish passage barriers, under CP5 could affect one species designated as sensitive by the USFS, the hardhead. Access to and the availability of suitable riverine habitat among all the main tributaries to the reservoir would not likely become any more limiting than under current conditions, nor would it greatly expand.

This impact would be similar to Impact Aqua-5 (CP3, CP4, or CP4A) and would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Aqua-6 (CP5): Creation or Removal of Barriers to Fish Between Tributaries and Shasta Lake Under CP5, project implementation would result in the periodic inundation of steep and low-gradient tributaries to Shasta Lake up to the 1,090-foot contour, the maximum inundation level under this alternative. Similar to CP3, CP5 would have small localized beneficial effects for adfluvial cold-water fishes and provide access to warm-water fish species, which would primarily be limited to the newly inundated reaches of the new varial zone of some streams. Impacts would not be expected to be much greater than under existing conditions. *Environmental commitments, described in Chapter 2, "Alternatives," to monitor fish communities in Squaw Creek and adaptively manage to prevent warmwater fish invasions would reduce this impact to a less than significant level.*

This impact would be similar to Impact Aqua-6 (CP3) and would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Aqua-7 (CP5): Effects on Spawning and Rearing Habitat of Adfluvial Salmonids in Low-Gradient Tributaries to Shasta Lake Similar to that described for CP3, CP5 would result in additional periodic inundation of potentially suitable spawning and rearing habitat for adfluvial salmonids in the tributaries of the Sacramento River, McCloud River, Pit River, Big Backbone Creek, and Squaw Creek upstream from Shasta Lake. A total of 11 miles of low-gradient reaches that could potentially provide some spawning and rearing habitat for adfluvial salmonids (estimated as 40,103 square feet for all tributaries) would be affected by CP5.

This impact would be potentially significant. Mitigation for this impact is proposed in Section 11.3.4, "Mitigation Measures."

Impact Aqua-8 (CP5): Effects on Aquatic Connectivity in Non-Fish-Bearing Tributaries to Shasta Lake CP5 would result in periodic inundation of the lower reaches of intermittent high-gradient, non-fish-bearing tributaries to Shasta Lake. About 24 miles of non-fish-bearing tributary habitat would be affected by CP5, which is only about 1 percent of the total length of non-fish-bearing tributaries upstream from Shasta Lake. Field surveys suggest that few, if any of the non-fish-bearing streams contain special-status invertebrate or vertebrate species that would be affected by increased connectivity to Shasta Lake. This impact would be less than significant.

This impact would be similar to Impact Aqua-8 (CP3) and would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Aqua-9 (CP5): Effects on Water Quality at Livingston Stone Hatchery Reclamation provides the water supply to the Livingston Stone Hatchery from a pipeline emanating from Shasta Dam. This supply would not be interrupted by any activity associated with CP5. There would be no impact.

This impact would be similar to Impact Aqua-9 (CP1), and there would be no impact. Mitigation for this impact is not needed, and thus not proposed.

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact Aqua-10 (CP5): Loss or Degradation of Aquatic Habitat in the Upper Sacramento River During Construction Activities Temporary construction-related increases in sediments and turbidity levels would adversely affect aquatic habitats and fish populations immediately downstream in the upper Sacramento River. However, environmental commitments would be in place to reduce the effects. This impact would be less than significant.

This impact would be similar to Impact Aqua-10 (CP1). The impact could be greater under CP5 than under CP1 because of the increased activity associated with an 18.5-foot dam raise compared to a 6.5-foot dam raise.

Like CP4 and CP4A, CP5 includes a 10-year gravel augmentation program as an additional environmental commitment. Placing gravel along the Sacramento River channel and bank annually would release an additional source of fine sediment and expose it to the river and aquatic communities. However, the gravel augmentation activities would occur only during previously specified in-water work windows, which would minimize the potential for impacts associated with this activity.

Also, like CP4 and CP4A, CP5 includes restoration of riparian, floodplain, and side-channel habitat in the upper Sacramento River at up to six potential restoration sites. Riparian, floodplain, and side-channel restoration at these sites could result in additional disturbed surfaces, but most of this construction is expected to occur away from the wetted channel, and all disturbed areas would be revegetated.

As under CP1, CP4, and CP4A, environmental commitments for all actions would be in place to reduce effects under CP5. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Aqua-11 (CP5): Release and Exposure of Contaminants in the Upper Sacramento River During Construction Activities Construction-related activities could result in the release and exposure of contaminants. Such exposure could adversely affect aquatic habitats, the aquatic food web, and fish populations, including special-status species, downstream in the primary study area. However, environmental commitments would be in place to reduce the effects. Therefore, this impact would be less than significant.

This impact would be similar to Impact Aqua-11 (CP1). The impact could be greater under CP5 than under CP1 because of the increased activity associated with an 18.5-foot raise compared to a 6.5-foot raise. Like CP4 and CP4A, CP5 includes implementation of a gravel augmentation program and restoration of riparian, floodplain, and side-channel habitat at up to six potential restoration sites. Both of these construction activities could cause additional sources of equipment-related contaminants to be released and exposed to the river and aquatic communities. However, environmental commitments for all actions would be in place to reduce effects. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Aqua-12 (CP5): Changes in Flow and Water Temperature in the Upper Sacramento River Resulting from Project Operation – Chinook Salmon and Steelhead Project operation under CP5 would generally result in improved flow and water temperature conditions in the upper Sacramento River for Chinook salmon and steelhead, but not all runs have an increase in production. As well, restoration actions that are proposed under CP5 would additional benefit Chinook salmon and steelhead. This impact would be beneficial.

Winter-Run Chinook Salmon

<u>Production</u>

The overall average winter-run production for the 1-year period was similar for CP5 relative to the No-Action Alternative and the Existing Condition (Attachments 3 and 4 of the Modeling Appendix). The maximum increase in production relative to the No-Action Alternative was 78 percent for CP5 (critical water year), while the largest decrease in production relative to the No-Action Alternative was around 49 percent (also a critical water year) (Table 11-49 and Attachment 3 of the Modeling Appendix). The maximum increase in production relative to the Existing Condition was 144 percent (critical water year) for CP5, while the largest decrease in production relative to the Existing Condition was around 26 percent (critical water year) (Table 11-49 and Attachment 4 of the Modeling Appendix). Figure 11-9 shows the change in production relative to the No-Action Alternative for all water years and all Comprehensive Plans.

Under CP5, four critical water years had significant increases in production relative to the No-Action Alternative for winter-run Chinook salmon. No other water year type had a significant increase in production. Two critical and one above-normal water year had a significant decrease in production.

Under CP5, four critical, one dry, and one below-normal water years had significant increases in production relative to the Existing Condition, while four years (one each in critical, dry, above-normal and wet water year types) had significant decreases in production greater than 5 percent.

Table 11-49. Change in Production Under CP5 for Winter-Run Chinook Salmon

Year Type	Number of Years	Average Production	Change in Production from Baseline	Percent Change in Average Production	Maximum Percent Increase in Production	Number of Years with Significant Increase	Maximum Percent Decrease in Production	Number of Years with Significant Decrease
Future Condition (2030)								
All	81	3,765,847	-35,268	-0.9	77.8	4	-48.7	3
Critical	13	3,348,152	-29,804	-0.9	77.8	4	-48.7	2
Dry	17	3,950,128	-22,202	-0.6	4.5	0	-3.5	0
Below Normal	14	3,929,045	-9,514	-0.2	2.8	0	-3.1	0
Above Normal	11	3,784,945	-73,985	-1.9	0.8	0	-7.4	1
Wet	26	3,758,247	-44,032	-1.2	3.8	0	-4.5	0
Existing Condition (2005)								
All	81	3,767,299	-13,948	-0.4	144	6	-26.3	4
Critical	13	3,312,821	101,881	3.2	144	4	-26.3	1
Dry	17	3,971,126	-12,736	-0.3	10.9	1	-6.6	1
Below Normal	14	3,940,814	665	0.0	5.1	1	-3.2	0
Above Normal	11	3,788,962	-63,720	-1.7	0.3	0	-5.5	1
Wet	26	3,758,670	-59,466	-1.6	1.7	0	-5.4	1

Note:

Production is the number of immature smolts surviving to pass the Red Bluff Pumping Plant

Key:

CP = Comprehensive Plan

Mortality

Mortality was separated by flow- and water temperature-related mortality to assess the level of impacts on winter-run Chinook salmon caused by the actions of the project (Attachments 3 and 4 of the Modeling Appendix). Nonoperations-related mortality are the base and seasonal mortality that would occur even without the effects of Shasta operations (such as disease, predation, and entrainment). Flow- and water temperature-related mortality is that caused by altering flow and water temperatures. In all cases, most mortality is caused by nonoperations-related factors (e.g., disease, predation, entrainment)−around 86 percent of the total mortality.

Mortality is presented in two manners–total mortality and smolt equivalent mortality (Attachments 3 and 4 of the Modeling Appendix). The greatest average mortality to winter-run Chinook salmon under CP5 (as with CP1 through CP4) in all water year types based on smolt equivalents would occur to the fry life stage, followed by eggs, then presmolts, and lastly to immature smolts. Table 11-5 displays the overall mortalities for each Comprehensive Plan that were caused by changes in operations (i.e., water temperature and flow) (Attachments 3 and 4 of the Modeling Appendix).

Years with the highest mortality were the same for the No-Action Alternative and the Existing Condition and CP5. Each of these years was a critical water year, and was preceded by either a critical (1933, 1976, 1991), or dry (1930, 1932) water year type. Years with the lowest mortality varied between all water year types. Years in which the project has the greatest effect on winter-run were also years in which the lowest production occurred (Attachments 3 and 4).

Winter-run Chinook salmon have a less-than-significant change to production and project-related mortality under CP5. Therefore, the actions taken in CP5 would result in less-than-significant impacts to winter-run Chinook salmon under both 2030 and 2005 conditions. Winter-run Chinook salmon will, however, benefit from the downstream restoration efforts, although this was not modeled with SALMOD. Mitigation for this impact is not needed, and thus not proposed.

Spring-Run Chinook Salmon

Production

Overall average spring-run Chinook salmon simulated production for CP5 is slightly higher relative to the No-Action Alternative and slightly lower than Existing Condition (Attachments 6 and 7 of the Modeling Appendix). The maximum increase in production relative to the No-Action Alternative was 143 percent for CP5 (critical water year), and the largest decrease in production relative to the No-Action Alternative was -37 percent (also a critical water year) (Table 11-50 and Attachment 6 of the Modeling Appendix). The maximum increase in production relative to the Existing Condition was 712 percent for CP5 and largest decrease in production was less than -27 percent (both in critical water years) (Table 11-50 and Attachment 7 of the Modeling Appendix).

Figure 11-10 shows the change in production relative to the No-Action Alternative for all water years and all Comprehensive Plans.

Under CP5, seven critical, two dry and one below-normal water years had significant increases in production relative to the No-Action Alternative. Production significantly decreased in four critical water years and one wet year.

Under CP5, 10 critical, 2 dry, and 1 below-normal water years had significant increases in production relative to the Existing Condition, and two critical and one wet water years had significant decreases in production relative to Existing Conditions.

Table 11-50. Change in Production Under CP5 for Spring-Run Chinook Salmon

Year Type	Number of Years	Average Production	Change in Production from Baseline	Percent Change in Average Production	Maximum Percent Increase in Production	Number of Years with Significant Increase	Maximum Percent Decrease in Production	Number of Years with Significant Decrease
Future Condition (2030)								
All	81	162,956	-1,098	-0.7	143	10	-37.3	4
Critical	13	81,451	262	0.3	143	7	-37.3	4
Dry	17	171,004	1,552	0.9	110	2	-1.8	0
Below Normal	14	176,922	-258	-0.1	20	1	-3.4	0
Above Normal	11	181,549	-2,217	-1.2	4.9	0	-3.3	0
Wet	26	183,061	-3,490	-1.9	1.5	0	-5.0	0
Existing Condition (2005)								
All	81	163,801	593	0.4	712	13	-26.7	3
Critical	13	86,086	12,024	16.2	712	10	-26.7	2
Dry	17	170,788	1,927	1.1	155	2	-1.7	0
Below Normal	14	177,764	-266	-0.1	21.9	1	-3.4	0
Above Normal	11	181,446	-2,667	-1.4	2.9	0	-3.4	0
Wet	26	183,107	-4,151	-2.2	2.1	0	-5.1	1

Note:

Production is the number of immature smolts surviving to pass the Red Bluff Pumping Plant

Key:

CP = Comprehensive Plan

Mortality

Mortality was separated by flow- and water temperature-related mortality to assess the level of impacts on spring-run Chinook salmon caused by the actions of the project (Attachments 6 and 7). In all cases, most mortality is caused by nonoperations-related factors (e.g., disease, predation, entrainment)−around 83 percent of the total mortality.

Mortality is presented in two manners–total mortality and smolt equivalent mortality (Attachments 6 and 7 of the Modeling Appendix). Under both the 2030 and 2005 conditions, the greatest mortality to spring-run under CP5 (as with CP1 through CP4) in all water year types based on smolt equivalents, occurred to eggs, with minimal mortality to the other life stages. Table 11-7 displays the smolt-equivalent mortalities for each Comprehensive Plan that are caused by flow- and water-related factors (also see Attachments 6 and 7 of the Modeling Appendix).

Years with the highest operations-related mortality were the same for the No-Action Alternative, Existing Conditions, and CP5. Except for 1932 (a dry water year), each of these years was a critical water year type and was preceded by either a below, dry, or (predominantly) a critical water year. However, years with the lowest mortality varied between all water year types (Attachments 6 and 7 of the Modeling Appendix).

Under both 2030 and 2005 conditions, spring-run Chinook salmon would experience a significant reduction in project-related mortality and significant increase in production during critical water years. Therefore, spring-run Chinook salmon would benefit from actions taken in CP5. Additionally, spring-run Chinook salmon will benefit from the downstream restoration efforts, although this was not modeled with SALMOD. Mitigation for this impact is not needed, and thus not proposed.

Fall-Run Chinook Salmon

Production

Overall average fall-run Chinook salmon simulated production for the simulation period was slightly higher for CP5 than for either the No-Action Alternative or Existing Condition (Attachments 9 and 10 of the Modeling Appendix). The maximum increase in production relative to the No-Action Alternative was almost 42 percent (in a below-normal water year) for CP5, and the largest decrease in was 36 percent (critical water year) (Table 11-47 and Attachment 9 of the Modeling Appendix). The maximum increase in production relative to the Existing Condition was around 162 percent (critical water year), and the largest decrease in production was 6.5 percent (wet water year) (Table 11-51 and Attachment 10 of the Modeling Appendix). Figure 11-11 shows the change in production relative to the No-Action Alternative for all water years and all Comprehensive Plans.

Table 11-51. Change in Production Under CP5 for Fall-Run Chinook Salmon

Year Type	Number of Years	Average Production	Change in Production from Baseline	Percent Change in Average Production	Maximum Percent Increase in Production	Number of Years with Significant Increase	Maximum Percent Decrease in Production	Number of Years with Significant Decrease
No-Action Alternative								
All	81	29,917,761	399,355	1.4	41.7	13	-36.0	4
Critical	13	27,603,770	1,158,942	4.4	34.9	4	-36.0	1
Dry	17	30,477,780	937,620	3.2	25.0	5	-2.4	0
Below Normal	14	31,664,669	566,758	1.8	41.7	2	-6.3	1
Above Normal	11	30,957,316	-75,694	-0.2	5.8	1	-1.8	0
Wet	26	29,328,136	-221,539	-0.7	5.0	1	-6.6	2
Existing Conditions								
All	81	30,073,307	644,966	2.2	162	13	-6.5	2
Critical	13	28,683,817	2,507,681	9.6	162	5	-1.5	0
Dry	17	30,474,368	1,013,967	3.4	24.4	5	-4.1	0
Below Normal	14	31,576,655	558,393	1.8	53.2	2	-5.8	1
Above Normal	11	30,739,508	-130,889	-0.4	3.0	0	-3.0	0
Wet	26	29,414,471	-152,799	-0.5	5.3	1	-6.5	1

Note:

Production is the number of immature smolts surviving to pass the Red Bluff Pumping Plant

Key:

CP = Comprehensive Plan

Under CP5, four critical, five dry, two below-normal, one above-normal, and one wet water year had significant increases in production relative to the No-Action Alternative. Significant decreases in production occurred in one critical, one below-normal, and two wet water years.

Compared with Existing Conditions, five critical, five dry, two below-normal, and one wet water year had significant increases in production. One below-normal and one wet water year resulted in significantly decreased production relative to the Existing Condition.

Mortality

Mortality was separated by flow- and water temperature-related mortality to assess the level of impacts on fall-run Chinook salmon caused by the actions of the project (Attachments 9 and 10). In all cases, most mortality is caused by nonoperations-related factors (e.g., disease, predation, entrainment)‒around 65 percent of the total mortality.

Mortality is presented in two manners–total mortality and smolt equivalent mortality (Attachments 9 and 10 of the Modeling Appendix). Under both 2030 and 2005 conditions, the greatest mortality based on the smolt equivalents to fall-run Chinook salmon under CP5 (as with CP1 through CP4) in all water year types based on smolt equivalents occurred to fry, followed by eggs, prespawn adults, presmolts, and lastly immature smolts. Flow-related effects triggered a higher percentage of the operations-related mortality (Table 11-9). In all water year types, the greatest portion of mortality under CP1 occurred to fry caused by forced movement to downstream habitats. Other non-flow- and water temperature-related conditions were the primary causes of mortality for all life stages except fry (Attachments 9 and 10 in the Modeling Appendix).

There was no real trend with respect to years with the greatest mortality. Years with the lowest production were in all water years except above-normal water years, and were preceded by all water year types.

Because fall-run Chinook salmon would have a significant reduction in mortality, but an insignificant change in average production, fall-run Chinook salmon would experience a less-than-significant impact from actions taken in CP5. Additionally, fall-run Chinook salmon would benefit from the downstream restoration efforts, although this was not modeled with SALMOD. Mitigation for this impact is not needed, and thus not proposed.

Late Fall-Run Chinook Salmon and Steelhead

Late fall-run Chinook salmon were evaluated directly using SALMOD and were considered to be a surrogate for steelhead; therefore, the following discussion regarding SALMOD results for late fall-run Chinook salmon are applicable to steelhead.

Production

Overall average late fall-run Chinook salmon simulated production for the 80-year period was similar to CP5 and the No-Action Alternative and the Existing Condition (Attachments 12 and 13 of the Modeling Appendix). The maximum increase in production relative to the No-Action Alternative was around 14 percent for CP5, while the largest decrease in production relative to the No-Action Alternative was just over 8 percent for CP5 (Table 11-52 and Attachment 12 of the Modeling Appendix). The maximum increase in production relative to the Existing Condition was 15 percent for CP5, while the largest decrease in production relative to the Existing Condition was less than 5 percent for CP5 (Table 11-52 and Attachment 13 of the Modeling Appendix). Figure 11-12 shows the change in production relative to the No-Action Alternative for all water years and all Comprehensive Plans.

Under CP5, one critical and three dry water years had significant increases in production compared to the No-Action Alternative. One critical water year had a significant decrease in production.

Under CP5, three critical and two dry water years had greater significant increases in production compared to the Existing Condition. There were no water years in which there was a significant decrease in production.

Table 11-52. Change in Production Under CP5 for Late Fall-Run Chinook Salmon

Year Type	Number of Years	Average Production	Change in Production from Baseline	Percent Change in Average Production	Maximum Percent Increase in Production	Number of Years with Significant Increase	Maximum Percent Decrease in Production	Number of Years with Significant Decrease
Future Condition (2030)								
All	80	7,433,301	14,815	0.2	13.8	4	-8.4	1
Critical	13	7,060,574	-3,595	-0.1	7.2	1	-8.4	1
Dry	16	7,474,409	120,040	1.6	13.8	3	-3.7	0
Below Normal	14	7,580,922	-31,696	-0.4	2.0	0	-3.2	0
Above Normal	11	7,601,343	15,259	0.2	2.5	0	-3.2	0
Wet	26	7,443,786	-15,878	-0.2	3.6	0	-3.9	0
Existing Condition (2005)								
All	80	7,439,596	53,035	0.7	15.4	6	-4.0	0
Critical	13	7,016,840	53,544	0.8	10.9	3	-2.0	0
Dry	16	7,506,162	145,894	2.0	15.4	3	-3.8	0
Below Normal	14	7,608,790	-2,304	0.0	2.9	0	-2.1	0
Above Normal	11	7,600,738	41,065	0.5	2.2	0	-1.0	0
Wet	26	7,450,731	30,499	0.4	4.8	0	-4.0	0

Notes:

Production is the number of immature smolts surviving to pass the Red Bluff Pumping Plant

Late fall-run Chinook salmon are used as a surrogate for steelhead

Key:

CP = Comprehensive Plan

Mortality

Mortality was separated by flow- and water temperature-related mortality to assess the level of impacts on late fall-run Chinook salmon caused by the actions of the project (Attachments 12 and 13). In all cases, most mortality is caused by nonoperations-related factors (e.g., disease, predation, entrainment)−around 78 percent of the total mortality.

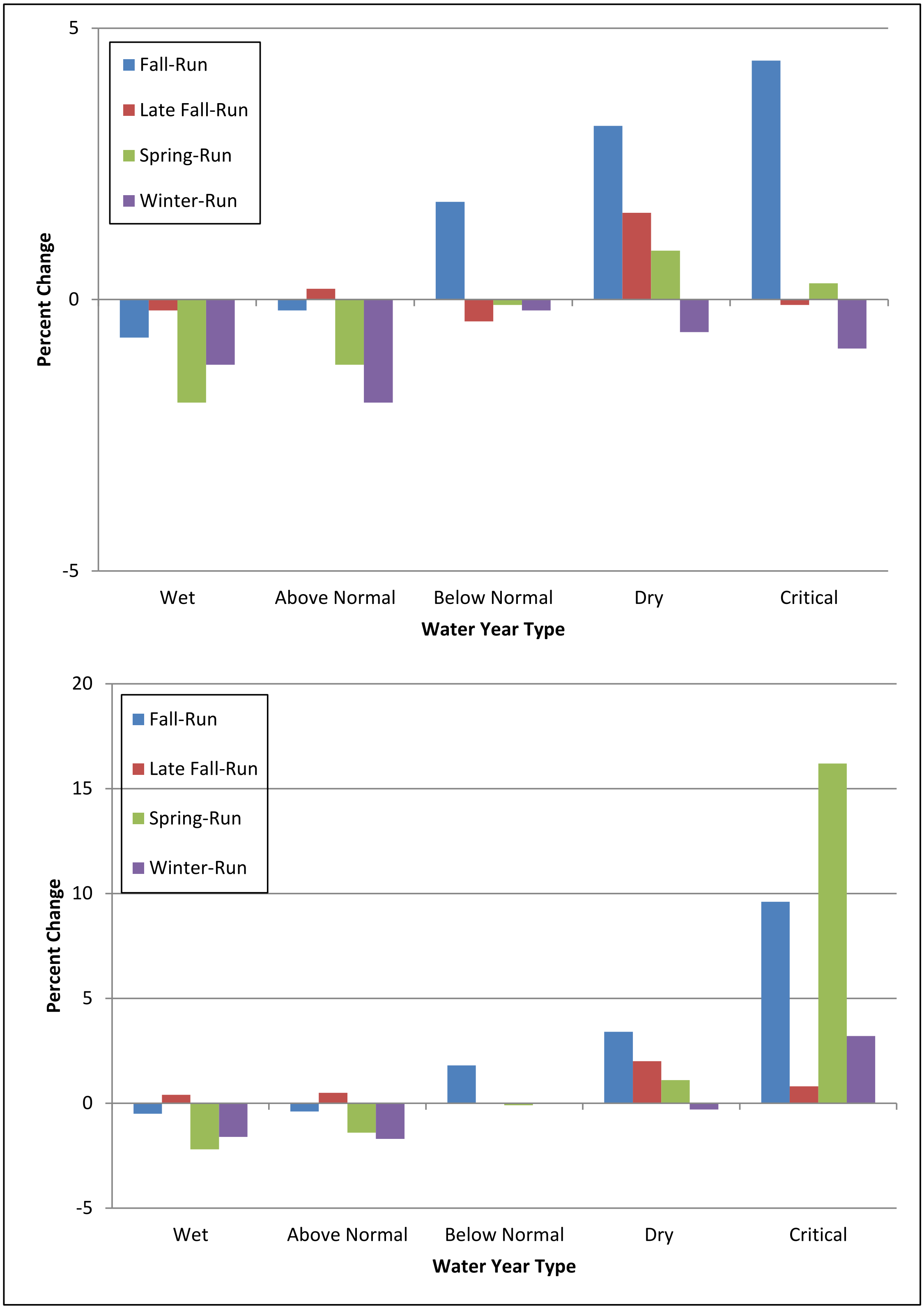
Mortality is presented in two manners–total mortality and smolt equivalent mortality (Attachments 12 and 13 of the Modeling Appendix). Under both 2030 and 2005 conditions, the largest mortality to late fall-run Chinook salmon under CP1 (as with CP1 and CP2) in all water year types based on smolt equivalents, occurred to the egg life stage, followed by fry, then presmolts, and lastly to immature smolts.

Years with the highest mortality were the same for CP5 and the No-Action Alternative and the Existing Condition, and occurred in all water year types. Four of these years were preceded by a wet water year, and the rest were each preceded by an above-normal, a below-normal, or a dry water year (Attachments 12 and 13 of the Modeling Appendix).

Because SALMOD indicates an insignificant change in mortality and production index for late fall-run Chinook salmon under CP5, late fall-run Chinook salmon and steelhead (as represented by their surrogate late fall-run Chinook salmon) would experience a less-than-significant impact from actions taken in CP5. Additionally, late fall-run Chinook salmon and steelhead will benefit from the downstream restoration efforts, although this was not modeled with SALMOD. Mitigation for this impact is not needed, and thus not proposed.

All Chinook Runs Combined

Raising Shasta Dam by 18.5 feet, in conjunction with spillway modifications, would result in an increase in full pool depth of 20.5 feet and an additional 634,000 acre-feet of storage capacity in Shasta Reservoir. The additional storage created by the dam raise would be used to improve the ability to meet water temperature objectives and habitat requirements for anadromous fish during drought years (see Figure 11-53). Under the 2030 conditions, overall production for all four runs of Chinook salmon combined would increase by nearly 378,000 immature smolts migrating below RDPP. Under the 2005 conditions, overall production for all four runs of Chinook salmon combined would increase by almost 685,000 immature smolts migrating below RDPP.



Note: Changes in outmigrating Chinook salmon simulated using SALMOD; Water Year Types based on the Sacramento Valley Water Year Hydrologic Classification

Figure 11-53. Percent Change in Production of Chinook Salmon for CP5 Compared to the No-Action Alternative (top) and Existing Conditions (bottom)

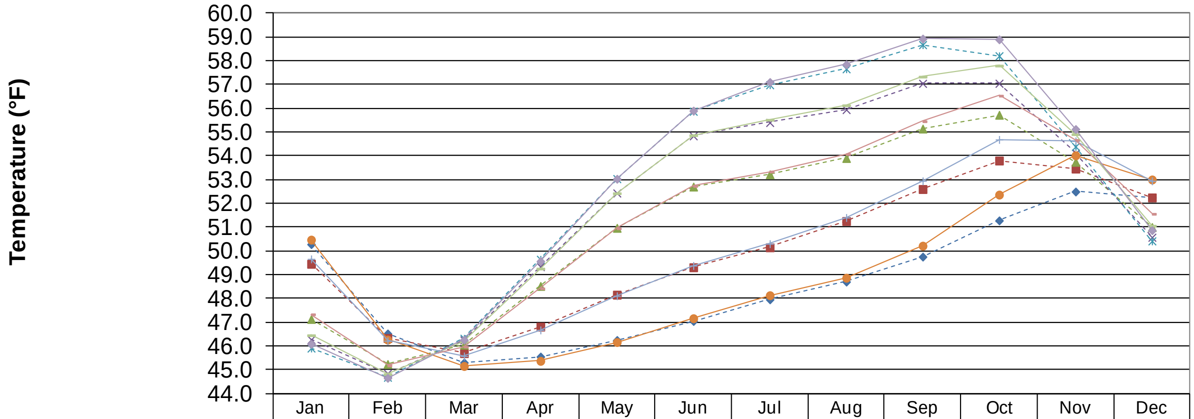
Impact Aqua-13 (CP5): Changes in Flow and Water Temperature in the Upper Sacramento River Resulting from Project Operation – Steelhead, Green Sturgeon, Sacramento Splittail, American Shad, and Striped Bass CP5 operations generally would result in slightly improved flow and water temperature conditions in the upper Sacramento River for steelhead, green sturgeon, Sacramento splittail, American shad, and striped bass. This impact would be less than significant.

This impact would be the same as Impact Aqua-13 (CP3). As under CP3, monthly mean flows at all modeling locations along the upper Sacramento River under CP5 would generally be equivalent to (less than 5-percent difference from) flows under the Existing Condition and No-Action Alternative conditions simulated for all months. Changes in monthly mean flows under CP5 would have no discernible effects on steelhead, green sturgeon, Sacramento splittail, American shad, or striped bass in the upper Sacramento River. Functional flows for migration, attraction, spawning, egg incubation, and rearing/emigration for these species would be unchanged.

Also, as under CP3, monthly mean water temperatures at all modeling locations along the upper Sacramento River under CP5 would be the same as or fractionally lower than those under the Existing Condition and No-Action Alternative simulated for all months (Figures 11-54 and 11-55). The slightly cooler monthly mean water temperatures under CP5 relative to the Existing Condition and the No-Action Alternative would have very small effects on steelhead, green sturgeon, Sacramento splittail, American shad, or striped bass. Monthly mean water temperatures would not rise above important thermal tolerances for the species life stages relevant to the upper Sacramento River.

Therefore, with respect to both flow- and water temperature-related effects on fish species, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CP5 vs Existing Condition (2005)

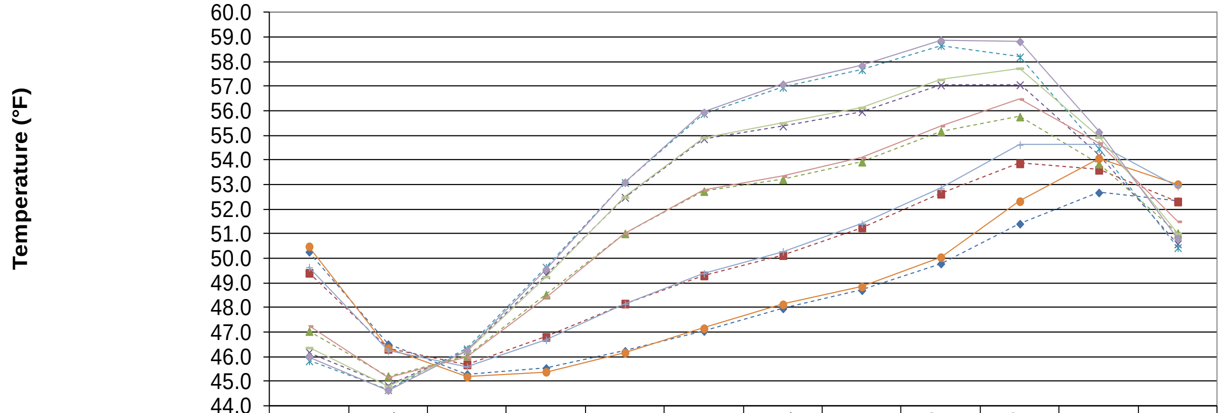


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CP5 Below Shasta	50.3	46.5	45.3	45.6	46.3	47.1	48.0	48.7	49.8	51.3	52.5	52.2
CP5 Below Keswick	49.5	46.3	45.7	46.8	48.2	49.3	50.1	51.3	52.6	53.8	53.5	52.2
CP5 Balls Ferry	47.1	45.2	46.1	48.5	51.0	52.7	53.2	53.9	55.1	55.7	53.7	51.0
CP5 Bend Bridge	46.3	44.9	46.3	49.3	52.4	54.8	55.4	55.9	57.0	57.0	54.1	50.6
CP5 RBPP	45.9	44.7	46.3	49.6	53.0	55.9	57.0	57.7	58.7	58.2	54.4	50.4
EC Below Shasta	50.5	46.3	45.2	45.4	46.2	47.2	48.1	48.9	50.2	52.4	54.0	53.0
EC Below Keswick	49.7	46.2	45.6	46.7	48.1	49.4	50.3	51.4	52.9	54.7	54.6	52.9
EC Balls Ferry	47.3	45.2	46.0	48.4	50.9	52.7	53.3	54.1	55.4	56.5	54.7	51.6
EC Bend Bridge	46.5	44.8	46.2	49.3	52.4	54.9	55.5	56.1	57.3	57.8	54.9	51.1
EC RBPP	46.1	44.7	46.3	49.6	53.0	55.9	57.1	57.8	58.9	58.9	55.1	50.9

Key: °F = degrees Fahrenheit EC = Existing Condition
CP = Comprehensive Plan RBPP = Red Bluff Pumping Plant

Figure 11-54. Changes in Mean Monthly Water Temperature at Modeled Locations in the Sacramento River Within the Primary Study Area (CP5 Versus Existing Condition)

CP5 vs No-Action (2030)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CP5 Below Shasta	50.3	46.5	45.3	45.5	46.2	47.0	48.0	48.7	49.8	51.4	52.7	52.3
CP5 Below Keswick	49.4	46.3	45.7	46.8	48.2	49.3	50.1	51.3	52.6	53.9	53.6	52.3
CP5 Balls Ferry	47.0	45.2	46.0	48.5	51.0	52.7	53.2	53.9	55.2	55.8	53.9	51.0
CP5 Bend Bridge	46.2	44.8	46.3	49.3	52.5	54.9	55.4	56.0	57.1	57.1	54.2	50.6
CP5 RBPP	45.8	44.7	46.3	49.6	53.1	55.9	57.0	57.7	58.7	58.2	54.5	50.4
NA Below Shasta	50.5	46.3	45.2	45.4	46.2	47.2	48.1	48.9	50.0	52.3	54.1	53.0
NA Below Keswick	49.6	46.2	45.6	46.7	48.1	49.4	50.3	51.4	52.9	54.6	54.6	52.9
NA Balls Ferry	47.3	45.2	46.0	48.4	51.0	52.8	53.3	54.1	55.4	56.5	54.7	51.5
NA Bend Bridge	46.4	44.8	46.2	49.3	52.5	54.9	55.5	56.1	57.3	57.7	54.9	51.0
NA RBPP	46.0	44.6	46.3	49.6	53.1	55.9	57.1	57.8	58.9	58.8	55.1	50.8

Key: °F = degrees Fahrenheit NA = No-Action
CP = Comprehensive Plan RBPP = Red Bluff Pumping Plant

Figure 11-55. Changes in Mean Monthly Water Temperature at Modeled Locations in the Sacramento River Within the Primary Study Area (CP5 Versus No-Action Alternative)

Impact Aqua-14 (CP5): Reduction in Ecologically Important Geomorphic Processes in the Upper Sacramento River Resulting from Reduced Frequency and Magnitude of Intermediate to High Flows Project operations could cause a reduction in the magnitude, duration, and frequency of intermediate to large flows both in the upper Sacramento River and in the lowermost (confluence) areas of tributaries. Such flows are necessary for channel forming and maintenance, meander migration, and the creation of seasonally inundated floodplains. These geomorphic processes are ecologically important because they are needed to maintain important aquatic habitat functions and values for fish and macroinvertebrate communities. This impact would be potentially significant.

This impact would be similar to Impact Aqua-14 (CP1). The impact could be greater under CP5 than under CP1 because the increased reservoir capacity associated with an 18.5-foot raise compared to a 6.5-foot raise would allow for storage of additional water volume (and flows) behind the raised dam.

Sediment transport, deposition, and scour regulate the formation of key habitat features such as point bars, gravel deposits, and SRA habitat. Intermediate to high flows and the associated stage elevation of the river surface also provide a backwater effect on the lowermost segment of tributaries, reducing the potential for downcutting. These processes are regulated by the magnitude and frequency of flow. Relatively large floods provide the energy required to mobilize sediment from the riverbed, produce meander migration, increase stage elevation, and create seasonally inundated floodplains. Operations under CP5 could result in a reduction in the intermediate to large flows necessary for channel forming and maintenance, meander migration, and the creation of seasonally inundated floodplains.

Implementation of CP5 would cause a further reduction in the magnitude, duration, and frequency of intermediate to large flows, relative to the Existing Condition and No-Action Alternative. Overall, the project would increase the existing, ongoing effects on geomorphic processes resulting from operation of Shasta Dam that are necessary for channel forming and maintenance, meander migration, and the creation of seasonally inundated floodplains. These effects would likely occur throughout the upper Sacramento River portion of the primary study area.

As discussed above, CP5 also includes a 10-year gravel augmentation program and the restoration of riparian, floodplain, and side-channel habitat at up to six potential restoration sites as additional environmental commitments. Placing gravel along the Sacramento River channel and bank annually and restoring riparian, floodplain, and side-channel habitat at up to six sites would result in benefits to ecological processes (e.g., sediment transport and deposition, floodplain inundation) that would partially offset the effects described above. Nevertheless, reductions in the magnitude of high flows would likely be sufficient to reduce ecologically important processes along the upper Sacramento River. This impact would be potentially significant. Mitigation for this impact is proposed in Section 11.3.4, “Mitigation Measures.”

Lower Sacramento River and Tributaries, Delta, and Trinity River

Impact Aqua-15 (CP5): Changes in Flow and Water Temperatures in the Lower Sacramento River and Tributaries and Trinity River Resulting from Project Operation – Fish Species of Primary Management Concern   Project operation would result in no discernible change in monthly mean flows or water temperature conditions in the lower Sacramento River. However, predicted changes in flow in the Feather, American, and Trinity rivers could result in adverse effects on Chinook salmon, steelhead, Coho salmon, green sturgeon, Sacramento splittail, American shad, and striped bass. This impact would be potentially significant.

This impact would be similar to Impact Aqua-15 (CP1). The impact could be greater under CP5 than under CP1 because the increased reservoir capacity associated with an 18.5-foot raise compared to a 6.5-foot raise would allow for storage of additional water volume (and increased cold-water pool) behind the raised dam.

As described below, mean monthly flows at various modeling locations on the lower Sacramento River and tributaries under CP5 were compared with mean monthly flows simulated for Existing Conditions and No-Action Alternative conditions. See the Modeling Appendix for complete CalSim-II modeling results.

Lower Sacramento River As under CP3, monthly mean flows at the lower Sacramento River modeling locations under CP5 would be essentially equivalent to flows under the Existing Condition and No-Action Alternative conditions simulated for all months. Differences in monthly mean flow were generally small (less than 2 percent) and within the existing range of variability. Potential changes in flows would diminish rapidly downstream from RBPP because of the increasing effects of tributary inflows, diversions, and flood bypasses. Potential flow-related effects of CP5 on fish species of management concern in the lower Sacramento River would be minimal. Potential changes in water temperatures in the lower Sacramento River caused by small changes in releases would diminish rapidly downstream because of the increasing effects of inflows, atmospheric influences, and groundwater. Therefore, flow- and temperature-related impacts on fish species in the lower Sacramento River would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Lower Feather River, American River, and Trinity River Also, as under CP3, monthly mean flows at all modeling locations on the lower Feather River, the American River, and the Trinity River under CP5 would be essentially equivalent to (less than 2-percent difference from) flows under the Existing Condition and No-Action Alternative simulated for most months. However, simulations for several months within the modeling record show substantial changes to flows in tributaries. Potential changes in flows could be reduced by real-time operations to meet existing rules, and because of operation of upstream reservoirs (Lake Oroville, Folsom Lake, and Trinity Lake) and increasing effects from tributary inflows, diversions, and flood bypasses. Based on predicted changes in flow and associated flow-habitat relationships, potential flow-related impacts on species of management concern in the American, Feather, and Trinity rivers could occur. This impact would be potentially significant. Mitigation for this impact is proposed in Section 11.3.4, "Mitigation Measures."

Impact Aqua-16 (CP5): Reduction in Ecologically Important Geomorphic Processes in the Lower Sacramento River Resulting from Reduced Frequency and Magnitude of Intermediate to High Flows Project operation could cause a reduction in intermediate to large flows both in the lower Sacramento River and in the lowermost (confluence) areas of tributaries. Such flows are necessary for channel forming and maintenance, meander migration, and the creation of seasonally inundated floodplains. These geomorphic processes are ecologically important because they are needed to maintain important aquatic habitat functions and values for fish and macroinvertebrate communities. This impact would be potentially significant.

This impact would be similar to Impact Aqua-16 (CP1). The impact could be greater under CP5 than under CP1 because the increased reservoir capacity associated with an 18.5-foot raise compared to a 6.5-foot raise would allow for storage of additional water volume (and flows) behind the raised dam.

Sediment transport, deposition, and scour regulate the formation of key habitat features such as point bars, gravel deposits, and SRA habitat. Intermediate to high flows and the associated stage elevation of the river surface also provide a backwater effect on the lowermost segment of tributaries, which reduces the potential for downcutting. These processes are regulated by the magnitude and frequency of flows. Relatively large floods provide the energy required to mobilize sediment from the bed, produce meander migration, increase stage elevation, create seasonally inundated floodplains, and inundate floodplain bypasses. Operations under CP5 could result in reduced intermediate to large flows that are necessary for channel forming and maintenance, meander migration, and the creation of seasonally inundated floodplains.

Implementation of CP5 would cause a further reduction in the magnitude, duration, and frequency of intermediate to large flows relative to the Existing Condition and No-Action Alternative. Overall, the project would increase the existing, ongoing impacts on geomorphic processes resulting from operation of Shasta Dam that are necessary for channel forming and maintenance, meander migration, the creation of seasonally inundated floodplains, and the inundation of floodplain bypasses. These effects would likely occur along the upper reaches of the lower Sacramento River.

Reductions in the magnitude of high flows would likely be sufficient to reduce ecologically important processes along the upper Sacramento River and its floodplain bypasses. This impact would be potentially significant. Mitigation for this impact is proposed in Section 11.3.4, “Mitigation Measures.”

Impact Aqua-17 (CP5): Effects to Delta Fisheries Resulting from Changes to Delta Outflow Based on the results of hydrologic modeling comparing Delta outflow under the No-Action Alternative, Existing Condition, and CP5, CP5 would result in changes to average monthly Delta outflow of less than 5 percent in all water year types (with the exception of September in dry years, November in above-normal years, and December of critical years). This impact on Delta fisheries and hydrologic transport processes within the Bay-Delta would be less than significant.

Results of the comparison of Delta outflows under CP5 compared with the Existing Condition and No-Action Alternative are summarized by month and water year type in Table 11-53. Under 2030 and 2005 conditions, Delta outflows would decrease by greater than 5 percent only in November of above-normal water years, but would not result in an overall significant impact to Delta fisheries. Under 2030 conditions, Delta outflows would increase by 5 percent in September and December. An increase in Delta outflow by 200 to 300 cfs during dry and critical water years would not result in significant impacts to Delta fisheries, particularly at flows between 3,500 and 6,000, while a decrease in Delta outflow by around 700 cfs when outflows are higher in November would also not result in significant impacts to Delta fisheries. Based on the results of this comparison, it was concluded that CP5 would have a less-than-significant impact on Delta fisheries and hydrologic transport processed within the Bay-Delta as a consequence of changes in Delta outflow under existing conditions. Mitigation for this impact is not needed, and thus not proposed.

Table 11-53. Delta Outflow Under Existing Conditions, No-Action Alternative, and CP5

		Existing Condition	CP5 (2005)		No-Action Alternative	CP5 (2030)	
Month	**Water Year**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**
January	Average	42,078	41,817	-1	42,169	41,806	-1
	W	84,136	83,584	-1	84,037	83,176	-1
	AN	47,221	46,892	-1	46,984	46,828	0
	BN	21,610	21,578	0	21,990	22,012	0
	D	14,166	13,956	-1	14,452	14,174	-2
	C	11,560	11,649	1	11,757	11,691	-1
February	Average	51,618	51,340	-1	51,430	51,033	-1
	W	95,261	94,826	0	94,634	94,068	-1
	AN	60,080	59,474	-1	60,278	59,353	-2
	BN	35,892	35,776	0	35,665	35,522	0
	D	20,978	20,804	-1	20,946	20,694	-1
	C	12,902	12,945	0	13,088	13,076	0
March	Average	42,722	42,532	0	42,585	42,469	0
	W	78,448	78,481	0	78,376	78,447	0
	AN	53,486	52,431	-2	53,139	52,313	-2
	BN	23,102	22,800	-1	22,980	22,746	-1
	D	19,763	19,873	1	19,559	19,659	1
	C	11,881	11,750	-1	11,893	11,895	0
April	Average	30,227	30,282	0	30,743	30,794	0
	W	54,640	54,674	0	55,460	55,472	0
	AN	32,141	32,147	0	32,971	32,976	0
	BN	21,773	21,903	1	22,511	22,598	0
	D	14,347	14,429	1	14,538	14,665	1
	C	9,100	9,121	0	8,873	8,897	0
May	Average	22,619	22,547	0	22,249	22,179	0
	W	41,184	41,151	0	40,543	40,526	0
	AN	24,296	24,183	0	24,454	24,242	-1
	BN	16,346	15,948	-2	15,989	15,625	-2
	D	10,554	10,660	1	10,116	10,265	1
	C	6,132	6,132	0	5,910	5,882	0

Table 11-53. Delta Outflow Under Existing Conditions, No-Action Alternative, and CP5 (contd.)

		Existing Condition	CP5 (2005)		No-Action Alternative	CP5 (2030)	
Month	Water Year	Flow (cfs)	Flow (cfs)	Percent Change	Flow (cfs)	Flow (cfs)	Percent Change
June	Average	12,829	12,756	-1	12,660	12,550	-1
	W	23,473	23,471	0	23,015	23,027	0
	AN	12,080	11,625	-4	11,799	11,433	-3
	BN	7,995	7,977	0	7,991	7,727	-3
	D	6,691	6,681	0	6,764	6,697	-1
	C	5,361	5,360	0	5,378	5,376	0
July	Average	7,864	7,864	0	7,864	7,855	0
	W	11,230	11,223	0	11,181	11,144	0
	AN	9,562	9,519	0	9,407	9,384	0
	BN	7,117	7,131	0	7,225	7,275	1
	D	5,005	5,006	0	5,052	5,019	-1
	C	4,034	4,074	1	4,098	4,130	1
August	Average	4,322	4,335	0	4,335	4,355	0
	W	5,302	5,274	-1	5,097	5,060	-1
	AN	4,000	4,000	0	4,000	4,000	0
	BN	4,000	4,000	0	4,002	4,008	0
	D	3,906	3,903	0	4,142	4,203	1
	C	3,520	3,676	4	3,699	3,811	3
September	Average	9,841	9,866	0	9,844	9,898	1
	W	19,695	19,717	0	19,702	19,736	0
	AN	11,784	11,771	0	11,849	11,836	0
	BN	3,876	3,862	0	3,913	3,950	1
	D	3,508	3,576	2	3,442	3,600	5
	C	3,008	3,061	2	3,005	3,029	1
October	Average	6,067	6,072	0	6,000	6,003	0
	W	7,926	7,870	-1	7,633	7,558	-1
	AN	5,309	5,293	0	5,476	5,536	1
	BN	5,479	5,559	1	5,502	5,546	1
	D	5,228	5,264	1	5,236	5,253	0
	C	4,741	4,765	1	4,714	4,757	1
November	Average	11,706	11,531	-1	11,675	11,466	-2
	W	17,717	17,590	-1	17,715	17,494	-1
	AN	12,667	11,767	-7	12,491	11,755	-6
	BN	8,543	8,509	0	8,686	8,557	-1
	D	8,482	8,481	0	8,414	8,386	0
	C	6,250	6,266	0	6,150	6,132	0

Table 11-53. Delta Outflow Under Existing Conditions, No-Action Alternative, and CP5 (contd.)

		Existing Condition	CP5 (2005)		No-Action Alternative	CP5 (2030)	
Month	**Water Year**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**
December	Average	21,755	21,437	-1	21,745	21,324	-2
	W	44,974	44,310	-1	44,661	43,598	-2
	AN	18,581	18,300	-2	18,562	18,271	-2
	BN	12,219	11,850	-3	12,326	12,008	-3
	D	8,531	8,517	0	8,803	8,678	-1
	C	5,580	5,578	0	5,677	5,954	5

Note:
A negative percentage change reflects a reduction in Delta outflow
Key:
AN = above-normal
BN = below-normal
C = critical
CP = Comprehensive Plan
cfs = cubic feet per second
D = dry
W = wet

Impact Aqua-18 (CP5): Effects to Delta Fisheries Resulting from Changes to Delta Inflow Based on the results of hydrologic modeling comparing Delta inflow under CP5 to the Existing Condition and No-Action Alternative, CP5 would not decrease average monthly Delta inflow by 5 percent or more in any year type (except in September of dry and critical years). This impact on Delta fisheries and hydrologic transport processes within the Bay-Delta would be less than significant.

Results of the comparison of Delta inflows are summarized by month and water year type in Table 11-54. Delta inflows were observed to be slightly lower under many of the CP5 operations and slightly higher than either the Existing Condition or the No-Action Alternative depending on month and water year type. Average monthly Delta inflow would increase by more than 5 percent during September of critical years compared to the Existing Condition, and during September of dry and critical years compared to the No-Action Alternative. Average monthly Delta inflow would not decrease by more than 5 percent in any water year type. Based on the results of this comparison, it was concluded that CP5 would have a less-than-significant effect on Delta fisheries and hydrologic transport processes within the Bay-Delta as a consequence of changes in Delta inflow. Mitigation for this impact is not needed, and thus not proposed.

Table 11-54. Delta Inflow Under Existing Conditions, No-Action Alternative, and CP5

		Existing Condition	CP5 (2005)		No-Action Alternative	CP5 (2030)	
Month		Flow (cfs)	Flow (cfs)	Percent Change	Flow (cfs)	Flow (cfs)	Percent Change
January	Average	47,426	47,149	-1	47,457	47,115	-1
	W	89,431	88,880	-1	89,328	88,469	-1
	AN	51,611	51,213	-1	51,267	51,053	0
	BN	27,269	27,240	0	27,576	27,598	0
	D	20,125	19,962	-1	20,371	20,094	-1
	C	16,699	16,677	0	16,749	16,882	1
February	Average	57,835	57,570	0	57,623	57,250	-1
	W	103,140	102,698	0	102,606	102,066	-1
	AN	65,379	64,552	-1	65,574	64,598	-1
	BN	41,782	41,781	0	41,374	41,253	0
	D	26,530	26,384	-1	26,431	26,214	-1
	C	17,818	18,008	1	17,958	18,014	0
March	Average	49,829	49,675	0	49,713	49,588	0
	W	87,688	87,738	0	87,703	87,801	0
	AN	61,498	60,673	-1	61,339	60,540	-1
	BN	30,569	30,264	-1	30,415	30,183	-1
	D	24,943	24,967	0	24,640	24,654	0
	C	15,933	15,916	0	15,896	15,884	0
April	Average	33,962	34,019	0	34,783	34,833	0
	W	58,684	58,717	0	60,017	60,019	0
	AN	35,588	35,595	0	36,738	36,744	0
	BN	25,351	25,482	1	26,403	26,490	0
	D	17,962	18,057	1	18,315	18,448	1
	C	12,817	12,838	0	12,635	12,663	0
May	Average	27,383	27,312	0	27,091	27,029	0
	W	46,973	46,941	0	46,494	46,476	0
	AN	28,466	28,354	0	28,711	28,502	-1
	BN	20,747	20,349	-2	20,427	20,062	-2
	D	14,882	14,988	1	14,534	14,686	1
	C	10,347	10,351	0	10,038	10,065	0
June	Average	22,171	22,115	0	22,090	22,001	0
	W	35,459	35,457	0	35,172	35,190	0
	AN	23,124	22,662	-2	22,776	22,410	-2
	BN	16,884	16,971	1	16,941	16,796	-1
	D	14,095	14,082	0	14,337	14,262	-1
	C	10,710	10,711	0	10,694	10,696	0
July	Average	23,099	23,160	0	22,839	22,959	1
	W	27,442	27,430	0	27,496	27,455	0
	AN	25,169	25,065	0	25,065	25,018	0
	BN	23,282	23,351	0	23,362	23,338	0
	D	20,937	20,983	0	20,082	20,408	2
	C	14,647	15,042	3	14,048	14,544	4

Table 11-54. Delta Inflow Under Existing Conditions, No-Action Alternative, and CP5 (contd.)

		Existing Condition	CP5 (2005)		No-Action Alternative	CP5 (2030)	
Month	Flow (cfs)	Flow (cfs)	Flow (cfs)	Percent Change	Flow (cfs)	Flow (cfs)	Percent Change
August	Average	17,147	17,154	0	17,026	17,128	1
	W	20,235	20,217	0	20,154	20,118	0
	AN	18,784	18,754	0	18,927	18,941	0
	BN	18,274	18,202	0	18,297	18,231	0
	D	15,066	15,348	2	14,371	14,976	4
	C	10,626	10,404	-2	10,850	10,782	-1
September	Average	20,946	21,184	1	21,145	21,461	1
	W	31,918	32,076	0	32,428	32,518	0
	AN	23,912	23,902	0	24,747	24,877	1
	BN	16,518	16,468	0	16,563	16,652	1
	D	14,440	14,960	4	14,233	15,039	6
	C	9,130	9,707	6	8,809	9,332	6
October	Average	14,407	14,469	0	14,175	14,278	1
	W	17,072	17,019	0	16,558	16,569	0
	AN	13,176	13,391	2	13,223	13,442	2
	BN	14,044	14,251	1	14,159	14,201	0
	D	13,133	13,264	1	12,846	13,135	2
	C	12,196	12,085	-1	11,976	11,956	0
November	Average	19,512	19,554	0	19,463	19,503	0
	W	26,429	26,491	0	26,536	26,433	0
	AN	20,269	19,631	-3	20,052	19,651	-3
	BN	16,984	17,064	0	16,980	16,972	0
	D	15,771	16,056	2	15,705	16,116	2
	C	12,330	12,595	2	12,081	12,372	0
December	Average	30,984	30,673	-1	30,988	30,568	-1
	W	53,758	53,109	-1	53,516	52,482	-2
	AN	28,431	28,177	-1	28,223	27,981	-1
	BN	21,958	21,606	-2	22,143	21,842	-1
	D	18,560	18,550	0	18,837	18,696	-1
	C	13,363	13,322	0	13,484	13,666	1

Note:
A negative percentage change reflects a reduction in Delta inflow

Key:
AN = above-normal
BN = below-normal
C = critical
cfs = cubic feet per second
CP = Comprehensive Plan
D = dry
W = wet

Impact Aqua-19 (CP5): Effects to Delta Fisheries Resulting from Changes in Sacramento River Inflow Project operation would result in a variable response in Sacramento River inflow, resulting in both increases and decreases in river flow above basis-of-comparison conditions depending on month and water year type. Decreases in Sacramento River inflow would not equal or exceed 5 percent. This impact would be less than significant.

Results of hydrologic modeling, by month and year type, for the Existing Condition, No-Action Alternative, and CP5 for Sacramento River inflow, are presented in Table 11-55. Results of these analyses show a variable response in Sacramento River inflow with CP5 operations resulting in both increases and decreases in river inflow above the Existing Condition and the No-Action Alternative, depending on month and water year. Under CP5, Sacramento River inflow would not decrease by 5 percent or more. Based on these results, the impact of CP5 on fish habitat and transport mechanisms within the lower Sacramento River and Delta would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 11-55. Sacramento River Inflow Under Existing Conditions, No-Action Alternative, and CP5

		Existing Condition	CP5 (2005)		No-Action Alternative	CP5 (2030)	
Month	**Water Year**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**
January	Average	31,139	31,046	0	31,167	31,076	0
	W	50,173	50,011	0	50,164	49,899	-1
	AN	38,122	37,945	0	38,006	37,975	0
	BN	22,370	22,420	0	22,540	22,643	0
	D	16,980	16,884	-1	17,109	16,929	-1
	C	14,384	14,362	0	14,322	14,455	1
February	Average	36,608	36,559	0	36,618	36,490	0
	W	56,740	56,751	0	56,637	56,637	0
	AN	44,453	43,913	-1	44,672	44,028	-1
	BN	30,911	31,090	1	30,780	30,832	0
	D	21,249	21,103	-1	21,237	21,002	-1
	C	14,830	15,020	1	15,075	15,129	0
March	Average	32,396	32,301	0	32,352	32,284	0
	W	49,248	49,293	0	49,403	49,459	0
	AN	44,060	43,672	-1	43,972	43,624	-1
	BN	23,188	22,866	-1	23,068	22,855	-1
	D	20,390	20,414	0	20,138	20,151	0
	C	12,971	12,954	0	12,942	12,930	0
April	Average	23,232	23,290	0	23,206	23,257	0
	W	37,918	37,953	0	38,019	38,025	0
	AN	26,053	26,062	0	26,039	26,048	0
	BN	17,518	17,648	1	17,439	17,526	0
	D	13,205	13,300	1	13,164	13,297	1
	C	10,295	10,316	0	10,067	10,095	0
May	Average	19,417	19,349	0	19,114	19,054	0
	W	32,095	32,071	0	31,800	31,789	0
	AN	21,204	21,092	-1	21,080	20,871	-1
	BN	14,530	14,133	-3	14,144	13,780	-3
	D	11,226	11,332	1	10,836	10,987	1
	C	8,148	8,152	0	7,874	7,901	0

Table 11-55. Sacramento River Inflow Under Existing Conditions, No-Action Alternative, and CP5 (contd.)

		Existing Condition	CP5 (2005)		No-Action Alternative	CP5 (2030)	
Month	**Water Year**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**
June	Average	16,508	16,452	0	16,511	16,420	-1
	W	24,092	24,090	0	23,905	23,920	0
	AN	16,598	16,136	-3	16,533	16,166	-2
	BN	13,792	13,879	1	13,822	13,677	-1
	D	12,283	12,271	0	12,569	12,493	-1
	C	9,492	9,493	0	9,516	9,517	0
July	Average	19,518	19,579	0	19,266	19,386	1
	W	20,071	20,058	0	20,058	20,016	0
	AN	22,070	21,966	0	21,976	21,927	0
	BN	21,232	21,301	0	21,374	21,350	0
	D	19,577	19,623	0	18,788	19,113	2
	C	13,683	14,077	3	13,100	13,596	4
August	Average	14,710	14,717	0	14,596	14,697	1
	W	16,285	16,266	0	16,189	16,152	0
	AN	16,418	16,388	0	16,561	16,575	0
	BN	16,112	16,040	0	16,170	16,105	0
	D	13,632	13,915	2	12,968	13,572	5
	C	9,570	9,348	-2	9,785	9,716	-1
September	Average	18,211	18,449	1	18,417	18,733	2
	W	27,839	27,997	1	28,337	28,426	0
	AN	21,244	21,234	0	22,088	22,218	1
	BN	14,088	14,038	0	14,147	14,236	1
	D	12,522	13,036	4	12,341	13,147	7
	C	7,664	8,241	8	7,347	7,869	7
October	Average	11,309	11,416	1	11,117	11,230	1
	W	13,419	13,506	1	13,040	13,080	0
	AN	10,499	10,714	2	10,571	10,790	2
	BN	11,053	11,259	2	11,195	11,242	0
	D	10,150	10,281	1	9,830	10,120	3
	C	9,587	9,477	-1	9,333	9,313	0
November	Average	15,640	15,710	0	15,605	15,694	1
	W	20,726	20,867	1	20,832	20,860	0
	AN	16,893	16,281	-4	16,666	16,319	-2
	BN	13,755	13,833	1	13,793	13,784	0
	D	12,720	13,004	2	12,723	13,134	3
	C	9,948	10,214	3	9,653	9,944	3

Table 11-55. Sacramento River Inflow Under Existing Conditions, No-Action Alternative, and CP5 (contd.)

		Existing Condition	CP5 (2005)		No-Action Alternative	CP5 (2030)	
Month	**Water Year**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**
December	Average	23,248	23,143	0	23,229	23,090	-1
	W	37,645	37,387	-1	37,434	37,102	-1
	AN	22,604	22,532	0	22,461	22,282	-1
	BN	16,930	16,902	0	17,103	17,083	0
	D	15,760	15,750	0	15,934	15,792	-1
	C	11,303	11,262	0	11,310	11,492	2

Note: A negative percentage change reflects a reduction in Sacramento River inflow
Key:
AN = above-normal
BN = below-normal
C = critical
cfs = cubic feet per second
CP = Comprehensive Plan
D = dry
W = wet

Impact Aqua-20 (CP5): Effects to Delta Fisheries Resulting from Changes in San Joaquin River Flow at Vernalis CP5 operation would result in no discernible change in San Joaquin River flows at Vernalis, and therefore no effects on fish habitat or transport mechanisms within the lower San Joaquin River and Delta compared with the Existing Condition and No-Action Alternative. There would be no impact.

Results of hydrologic modeling, by month and water year type, for the Existing Condition, No-Action Alternative, and CP5 for San Joaquin River flow are summarized in Table 11-56. Results of these analyses show that CP5 would have no effect on seasonal San Joaquin River flows compared with the Existing Condition and No-Action Alternative. Based on these results CP5 would have no impact on Delta fisheries or transport mechanisms within the lower San Joaquin River and Delta. Mitigation for this impact is not needed, and thus not proposed.

Table 11-56. San Joaquin River Flow at Vernalis Under Existing Conditions, and CP5

		Existing Condition	CP5 (2005)		No-Action Alternative	CP5 (2030)	
Month	**Water Year**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**
January	Average	4,770	4,770	0	4,764	4,764	0
	W	9,273	9,273	0	9,097	9,097	0
	AN	4,223	4,223	0	4,259	4,259	0
	BN	2,986	2,986	0	3,081	3,081	0
	D	2,084	2,084	0	2,160	2,160	0
	C	1,673	1,673	0	1,746	1,746	0

Table 11-56. San Joaquin River Flow at Vernalis Under Existing Conditions, and CP5 (contd.)

		Existing Condition	CP5 (2005)		No-Action Alternative	CP5 (2030)	
Month	**Water Year**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**
February	Average	6,265	6,265	0	6,143	6,143	0
	W	11,036	11,036	0	10,845	10,845	0
	AN	6,047	6,047	0	6,179	6,179	0
	BN	5,767	5,767	0	5,565	5,565	0
	D	2,642	2,642	0	2,528	2,528	0
	C	2,161	2,161	0	2,014	2,014	0
March	Average	7,133	7,133	0	7,003	7,003	0
	W	13,443	13,443	0	13,170	13,170	0
	AN	6,788	6,788	0	6,674	6,673	0
	BN	5,322	5,322	0	5,293	5,293	0
	D	2,963	2,963	0	2,895	2,895	0
	C	2,176	2,176	0	2,129	2,129	0
April	Average	6,720	6,720	0	7,533	7,533	0
	W	11,420	11,420	0	12,614	12,614	0
	AN	6,671	6,671	0	7,799	7,798	0
	BN	5,852	5,852	0	6,910	6,910	0
	D	3,726	3,726	0	4,112	4,112	0
	C	2,087	2,087	0	2,118	2,118	0
May	Average	6,204	6,204	0	6,234	6,234	0
	W	11,268	11,268	0	11,135	11,135	0
	AN	5,611	5,611	0	5,987	5,987	0
	BN	5,010	5,010	0	5,108	5,108	0
	D	3,070	3,070	0	3,111	3,111	0
	C	1,920	1,920	0	1,862	1,862	0
June	Average	4,739	4,739	0	4,671	4,671	0
	W	9,451	9,451	0	9,390	9,390	0
	AN	5,608	5,609	0	5,326	5,326	0
	BN	2,424	2,424	0	2,471	2,470	0
	D	1,598	1,598	0	1,554	1,554	0
	C	1,076	1,076	0	1,035	1,035	0
July	Average	3,202	3,202	0	3,208	3,208	0
	W	6,556	6,556	0	6,660	6,660	0
	AN	2,783	2,784	0	2,767	2,768	0
	BN	1,775	1,775	0	1,733	1,733	0
	D	1,282	1,282	0	1,216	1,216	0
	C	898	898	0	880	880	0

Table 11-56. San Joaquin River Flow at Vernalis Under Existing Conditions, and CP5 (contd.)

		Existing Condition	CP5 (2005)		No-Action Alternative	CP5 (2030)	
Month	Water Year	Flow (cfs)	Flow (cfs)	Percent Change	Flow (cfs)	Flow (cfs)	Percent Change
August	Average	2,029	2,029	0	2,040	2,041	0
	W	3,099	3,099	0	3,158	3,159	0
	AN	2,020	2,020	0	2,014	2,015	0
	BN	1,828	1,828	0	1,817	1,816	0
	D	1,342	1,342	0	1,315	1,315	0
	C	984	984	0	993	993	0
September	Average	2,331	2,331	0	2,340	2,340	0
	W	3,274	3,274	0	3,317	3,317	0
	AN	2,328	2,328	0	2,312	2,312	0
	BN	2,109	2,109	0	2,119	2,119	0
	D	1,795	1,795	0	1,774	1,775	0
	C	1,358	1,358	0	1,355	1,355	0
October	Average	2,757	2,757	0	2,753	2,753	0
	W	3,112	3,112	0	3,107	3,107	0
	AN	2,446	2,446	0	2,424	2,424	0
	BN	2,749	2,749	0	2,718	2,718	0
	D	2,686	2,686	0	2,710	2,710	0
	C	2,416	2,416	0	2,423	2,423	0
November	Average	2,633	2,633	0	2,603	2,603	0
	W	3,372	3,372	0	3,340	3,340	0
	AN	2,213	2,213	0	2,176	2,176	0
	BN	2,412	2,412	0	2,360	2,360	0
	D	2,388	2,388	0	2,355	2,355	0
	C	2,075	2,075	0	2,088	2,088	0
December	Average	3,199	3,199	0	3,263	3,263	0
	W	5,081	5,081	0	5,178	5,178	0
	AN	2,916	2,916	0	2,899	2,899	0
	BN	2,705	2,705	0	2,753	2,753	0
	D	2,047	2,047	0	2,123	2,123	0
	C	1,710	1,710	0	1,785	1,785	0

Note:
A negative percentage change reflects a reduction in San Joaquin River inflow
Key:
AN = above-normal
BN = below-normal
C = critical
cfs = cubic feet per second
CP = Comprehensive Plan
D = dry
W = wet

Impact Aqua-21 (CP5): Reduction in Low-Salinity Habitat Conditions Resulting from an Upstream Shift in X2 Location CP5 operation would result in less than 0.5 km movement upstream or downstream from the X2 location from its location under the Existing Condition or No-Action Alternative during February through May and September through November, and thus cause minimal reduction in low-salinity habitats. This impact would be less than significant.

The 1 km X2 criterion was applied to a comparison of hydrologic model results for the Existing Condition, No-Action Alternative, and CP5, by month and water year type, for the months from February through May and September through November. Results of the comparisons are summarized in Table 11-57. These results showed that changes in X2 location under CP5 were less than 1 km (all were less than 0.4 km) with both variable upstream and downstream movement of the X2 location depending on month and water year type. These results are consistent with model results for Delta outflow that showed a less-than-significant change in flows. Based on these results, CP5 would have a less-than-significant impact on low-salinity habitat conditions within the Bay-Delta. Mitigation for this impact is not needed, and thus not proposed.

Table 11-57. Difference in X2 Under Existing Conditions, No-Action Alternative, and CP5

		Existing Condition	CP5 (2005)		No-Action Alternative	CP5 (2030)	
Month	**Water Year**	**Location (km)**	**Location (km)**	**Difference (km)**	**Location (km)**	**Location (km)**	**Difference (km)**
January	Average	67.5	67.5	0.0	67.3	67.3	0.0
	W	53.6	53.7	0.1	53.7	53.8	0.1
	AN	61.7	61.7	0.0	61.6	61.5	0.0
	BN	72.1	72.0	-0.1	71.7	71.6	-0.1
	D	77.9	78.0	0.1	77.4	77.6	0.2
	C	82.2	82.1	-0.1	81.9	81.8	-0.2
February	Average	60.9	61.0	0.0	60.8	60.9	0.1
	W	50.4	50.4	0.0	50.4	50.4	0.0
	AN	54.8	54.8	0.0	54.6	54.6	0.1
	BN	61.0	61.0	0.0	60.9	60.9	0.0
	D	70.1	70.2	0.1	69.9	70.0	0.1
	C	76.2	76.2	0.0	75.9	75.9	0.0
March	Average	60.9	61.0	0.0	60.9	60.9	0.0
	W	52.1	52.1	0.0	52.1	52.1	0.0
	AN	53.6	53.8	0.1	53.7	53.7	0.0
	BN	63.3	63.4	0.2	63.3	63.5	0.1
	D	67.1	67.0	-0.1	67.2	67.1	0.0
	C	75.2	75.3	0.1	75.1	75.1	0.0
April	Average	63.5	63.5	0.0	63.4	63.4	0.0
	W	54.5	54.5	0.0	54.3	54.3	0.0
	AN	58.6	58.6	0.0	58.4	58.4	0.0
	BN	64.5	64.5	0.0	64.1	64.1	0.0
	D	69.9	69.8	-0.1	69.9	69.7	-0.1
	C	77.5	77.4	0.0	77.6	77.7	0.0

Table 11-57. Difference in X2 Under Existing Conditions, No-Action Alternative, and CP5 (contd.)

		Existing Condition	CP5 (2005)		No-Action Alternative	CP5 (2030)	
Month	**Water Year**	**Location (km)**	**Location (km)**	**Difference (km)**	**Location (km)**	**Location (km)**	**Difference (km)**
May	Average	67.5	67.5	0.0	67.7	67.6	0.0
	W	57.6	57.6	0.0	57.7	57.7	0.0
	AN	62.7	62.7	0.0	62.6	62.6	0.0
	BN	68.3	68.4	0.1	68.3	68.4	0.1
	D	74.4	74.2	-0.2	74.8	74.6	-0.2
	C	82.5	82.5	0.0	82.9	82.9	0.0
June	Average	74.5	74.6	0.0	74.7	74.8	0.1
	W	65.0	65.0	0.0	65.2	65.2	0.0
	AN	72.6	72.8	0.2	72.7	72.9	0.2
	BN	76.6	76.6	0.0	76.7	76.9	0.3
	D	80.4	80.4	-0.1	80.7	80.6	-0.1
	C	85.9	85.8	0.0	86.0	86.1	0.0
July	Average	80.5	80.5	0.0	80.5	80.6	0.0
	W	74.4	74.4	0.0	74.5	74.5	0.0
	AN	78.1	78.3	0.2	78.4	78.5	0.1
	BN	81.7	81.7	0.0	81.6	81.7	0.1
	D	84.8	84.8	0.0	84.8	84.8	0.1
	C	88.1	88.0	0.0	88.0	88.0	0.0
August	Average	85.6	85.5	0.0	85.6	85.5	0.0
	W	82.7	82.7	0.0	82.8	82.9	0.0
	AN	83.7	83.8	0.0	83.9	83.9	0.0
	BN	85.6	85.5	0.0	85.5	85.4	-0.1
	D	87.8	87.8	0.0	87.5	87.5	0.0
	C	90.4	90.2	-0.2	90.2	90.1	-0.1
September	Average	83.7	83.6	0.0	83.7	83.6	-0.1
	W	73.4	73.4	0.0	73.5	73.5	0.0
	AN	81.4	81.4	0.0	81.4	81.4	0.0
	BN	88.8	88.9	0.0	88.8	88.7	0.0
	D	90.2	90.1	-0.1	90.0	89.8	-0.2
	C	92.5	92.3	-0.2	92.3	92.2	-0.1
October	Average	83.9	83.8	-0.1	83.9	83.8	-0.1
	W	73.6	73.5	0.0	73.7	73.7	0.0
	AN	79.8	79.8	0.0	79.8	79.9	0.0
	BN	88.9	88.9	0.0	88.9	88.9	0.0
	D	91.4	91.3	-0.2	91.3	91.2	-0.1
	C	93.3	93.1	-0.2	93.1	92.7	-0.4

Table 11-57. Difference in X2 Under Existing Conditions, No-Action Alternative, and CP5 (contd.)

		Existing Condition	CP5 (2005)		No-Action Alternative	CP5 (2030)	
Month	**Water Year**	**Location (km)**	**Location (km)**	**Difference (km)**	**Location (km)**	**Location (km)**	**Difference (km)**
November	Average	82.2	82.3	0.1	82.2	82.3	0.1
	W	73.1	73.1	0.0	73.2	73.2	0.0
	AN	78.4	78.4	0.0	78.4	78.5	0.1
	BN	84.8	85.3	0.6	84.8	85.4	0.6
	D	88.9	88.9	-0.1	88.8	88.9	0.1
	C	92.6	92.6	-0.1	92.8	92.5	-0.2
December	Average	76.1	76.2	0.1	76.0	76.1	0.1
	W	62.9	63.0	0.1	63.0	63.2	0.2
	AN	76.4	76.9	0.4	76.4	76.8	0.4
	BN	81.4	81.4	0.0	81.1	81.2	0.0
	D	82.8	82.8	0.0	82.6	82.7	0.1
	C	87.9	87.8	0.0	87.8	87.5	-0.3

Key:
AN = above-normal
BN = below-normal
C = critical
CP = Comprehensive Plan
D = dry
km = kilometer
W = wet

Impact Aqua-22 (CP5): Increase in Mortality of Species of Primary Management Concern as a Result of Increased Reverse Flows in Old and Middle Rivers CP5 operation would result in minimal increases in reverse flows in Old and Middle rivers during January, March and April; however, flows do not exceed (become more negative) -5,000 cfs. Because the flows do not exceed -5,000 cfs, the increases in reverse flows are not expected to contribute to an increase in the vulnerability of delta smelt, longfin smelt, Chinook salmon, juvenile striped bass, or threadfin shad, but summer Old and Middle river flows could contribute to an increase in vulnerability of other resident warm-water fish to increased salvage and potential losses. This impact would be less than significant.

Results of the analysis showed several occurrences when reverse flows within Old and Middle rivers would be higher than either 2005 or 2030 conditions by more than 5 percent. These events would mainly occur in critical water years, which would be expected as a result of greater export operations under CP5. An increase in average monthly reverse flows of 5 percent also would occur in March of above-normal years.

During January (Table 11-58), operations under CP5 resulted in an increase in reverse flow of 5 percent during critical years compared with the No-Action Alternative. Based on results of the delta smelt analysis of the relationship between reverse flows and delta smelt salvage, the increase of approximately 200 cfs in a critical water year would not be expected to result in a significant increase in adverse effects to delta smelt or longfin smelt.

Table 11-58. Old and Middle River Reverse Flows Under Existing Conditions, No-Action Alternative, and CP5

		Existing Condition	CP5 (2005)		No-Action Alternative	CP5 (2030)	
Month	**Water Year**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**
January	Average	-3,542	-3,526	0	-3,553	-3,572	1
	W	-2,034	-2,034	0	-2,151	-2,151	0
	AN	-3,654	-3,586	-2	-3,574	-3,523	-1
	BN	-4,240	-4,240	0	-4,240	-4,240	0
	D	-4,773	-4,814	1	-4,772	-4,771	0
	C	-4,033	-3,936	-2	-3,940	-4,123	5
February	Average	-3,293	-3,300	0	-3,358	-3,374	0
	W	-2,745	-2,735	0	-2,950	-2,973	1
	AN	-3,248	-3,035	-7	-3,165	-3,114	-2
	BN	-3,335	-3,437	3	-3,291	-3,312	1
	D	-4,016	-4,036	0	-4,045	-4,065	0
	C	-3,391	-3,528	4	-3,482	-3,542	2
March	Average	-2,784	-2,817	1	-2,877	-2,869	0
	W	-1,792	-1,808	1	-2,023	-2,048	1
	AN	-4,021	-4,230	5	-4,260	-4,281	1
	BN	-4,005	-4,002	0	-3,982	-3,985	0
	D	-2,951	-2,872	-3	-2,918	-2,838	-3
	C	-2,023	-2,125	5	-1,994	-1,979	-1
April	Average	955	954	0	1,060	1,063	0
	W	2,706	2,706	0	2,798	2,806	0
	AN	1,087	1,087	0	1,314	1,314	0
	BN	697	697	0	898	898	0
	D	-244	-249	2	-207	-206	0
	C	-874	-874	0	-872	-872	0
May	Average	491	491	0	416	409	-2
	W	2,077	2,077	0	1,781	1,781	0
	AN	562	562	0	646	646	0
	BN	277	277	0	270	270	0
	D	-674	-674	0	-696	-695	0
	C	-1,018	-1,022	0	-936	-984	5

Table 11-58. Old and Middle River Reverse Flows Under Existing Conditions, No-Action Alternative, and CP5 (contd.)

		Existing Condition	CP5 (2005)		No-Action Alternative	CP5 (2030)	
Month	**Water Year**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**	**Flow (cfs)**	**Flow (cfs)**	**Percent Change**
June	Average	-3,654	-3,669	0	-3,718	-3,737	0
	W	-4,226	-4,226	0	-4,354	-4,359	0
	AN	-4,825	-4,819	0	-4,818	-4,818	0
	BN	-4,137	-4,233	2	-4,119	-4,227	3
	D	-3,079	-3,079	0	-3,205	-3,198	0
	C	-1,542	-1,542	0	-1,542	-1,542	0
July	Average	-9,502	-9,559	1	-9,292	-9,402	1
	W	-8,948	-8,943	0	-8,905	-8,901	0
	AN	-9,993	-9,936	-1	-9,929	-9,906	0
	BN	-10,886	-10,937	0	-10,903	-10,853	0
	D	-10,998	-11,051	0	-10,419	-10,692	3
	C	-6,355	-6,672	5	-5,928	-6,354	7

Note:
A positive percentage change reflects more negative reverse flows under CP5 when compared to the Existing Condition or the No-Action Alternative.
Key:
AN = above-normal
BN = below-normal
C = critical
cfs = cubic feet per second
CP = Comprehensive Plan
D = dry
W = wet

Juvenile Chinook salmon and steelhead are migrating through the Delta during January, and an increase in average monthly reverse flows of around 200 cfs would be expected to increase the potential risk of increased mortality to these species. However, given the tidal volumes and hydrodynamics of the Old and Middle rivers region, it is not expected that the change in reverse flows in January in a critical year would result in a detectable change in fish survival. The majority of juvenile Chinook salmon emigrating from the San Joaquin River typically migrate downstream later in dry years and would not be expected to occur in high numbers within Old and Middle rivers in January.

The increase in average monthly reverse flows estimated to occur under CP5 in critical and above-normal water years in March (under 2005 conditions), in critical years in May (under 2030 conditions), and in critical years in July (under both 2005 and 2030 conditions) would exceed 5 percent. This increase could negatively affect resident warm water fish species.

Juvenile and larval delta smelt occur in the area in March through May, and juvenile and larval longfin smelt are present in March. A change in Old and Middle river flows of approximately 100 to 200 cfs may result in an increase in their vulnerability to CVP and SWP salvage, but this increase is expected to be less than significant. The increased reverse flows in May of critical water years would occur at a time of year when water temperatures in the Delta are typically increasing and juvenile Chinook salmon or steelhead may be more abundant in the area. However, changes to reverse flows in March and May would not exceed the -5,000 cfs criteria established by the USFWS and NMFS BOs, and would result in less-than-significant impacts to Chinook salmon and steelhead.

The increased average monthly reverse flows in July of critical years would occur at a time of year when water temperatures in the Delta are elevated and juvenile Chinook salmon or steelhead would not be expected to be present in the area. Longfin smelt would not be expected in the area, and low numbers of juvenile delta smelt may occur in the area in July. However, as water temperatures increase in the Delta during June and July, the majority of delta smelt are located farther downstream in Suisun Bay where temperatures are more suitable. Therefore, changes in reverse flows in July would result in less-than-significant impacts to Chinook salmon, steelhead delta smelt and longfin smelt.

The increase in reverse flows estimated from the modeling in July of a critical water year would be expected to contribute to a small increase in the vulnerability of juvenile striped bass, threadfin shad, and other resident warm-water fish to increased salvage and potential losses as a result of increased reverse flows. The increased reverse flows in low-flow years would be expected to result in a small but less-than-significant increase in mortality for resident warm-water fish inhabiting the south Delta.

The potential increase in losses during January, March and May under CP5 is considered to be less than significant for Chinook salmon, steelhead, delta smelt and longfin smelt. Mitigation for this impact is not proposed because operations will be guided by RPAs established by NMFS and USFWS BOs to reduce any impacts to listed fish species, and thus reduce effects to non-listed fish species as well.

Impact Aqua-23 (CP5): Increase in the Risk of Entrainment or Salvage of Species of Primary Management Concern at CVP and SWP Export Facilities Due to Changes in CVP and SWP Exports CP5 operations may result in an increase in CVP and SWP exports, which is assumed to result in a direct proportional increase in the risk of fish being entrained and salvaged at the facilities. Future operations of the SWP and CVP export facilities would continue to be managed and regulated in accordance with incidental take limits established for each of the protected fish by USFWS, NMFS, and CDFW. The resulting impact to Chinook salmon and steelhead would be less than significant; the resulting impact to delta smelt, longfin smelt striped bass, and splittail would be potentially significant. Overall, this impact would be potentially significant.

Results of the entrainment loss modeling at the CVP and SWP export facilities are presented in Table 11-59 for CP5. The estimated index of total numbers of fish lost annually, by species, is presented in Attachment 1 of the *Fisheries and Aquatic Ecosystems Technical Report.* The difference between the nonoperations related and operations related fish mortality is represented as the entrainment index, shown in Table 11-55, to represent the effect of project operations on each selected fish species at the CVP and SWP facilities.

Table 11-59. Entrainment at the CVP and SWP Facilities Comparing Existing Conditions, No-Action Alternative, and CP5

Species	Water Year	CP5 minus Existing Condition	Percent Change	CP5 Minus Future Condition	Percent Change
Delta Smelt	Average	60	0.1	162	0.4
	W	-4	-0.0	22	0.0
	AN	-56	-0.1	-22	-0.1
	BN	289	0.8	286	0.8
	D	15	0.0	30	0.1
	C	114	0.5	707	3.1
Chinook Salmon	Average	67	0.1	124	0.2
	W	4	0.0	42	0.1
	AN	-96	-0.2	-79	-0.2
	BN	257	0.6	169	0.4
	D	-8	-0.0	-59	-0.1
	C	255	0.7	728	2.2
Longfin Smelt	Average	2	0.0	21	0.3
	W	-1	-0.0	-4	-0.0
	AN	2	0.0	0	-0.0
	BN	3	0.1	3	0.1
	D	2	0.0	0	-0.0
	C	11	0.2	149	3.0
Steelhead	Average	7	0.2	7	0.2
	W	1	0.0	10	0.2
	AN	-26	-0.6	-17	-0.4
	BN	28	0.7	7	0.2
	D	-2	-0.1	-8	-0.2
	C	41	1.5	47	1.7
Striped Bass	Average	7,044	0.5	11,575	0.9
	W	1,854	0.1	2,393	0.1
	AN	-214	-0.0	2,958	0.2
	BN	13,841	1.0	9,181	0.7
	D	9,518	0.9	24,383	2.2
	C	13,907	2.2	23,669	4.0

Table 11-59. Entrainment at the CVP and SWP Facilities Comparing Existing Conditions, No-Action Alternative, and CP5 (contd.)

Species	Water Year	CP5 minus Existing Condition	Percent Change	CP5 Minus Future Condition	Percent Change
Splittail	Average	1,075	0.4	1,753	0.7
	W	-31	-0.0	171	0.0
	AN	-727	-0.2	-195	-0.1
	BN	3,671	1.4	3,108	1.2
	D	588	0.3	2,498	1.2
	C	2,976	2.9	4,432	4.6

Note:
Negative percentage change reflects a reduction in entrainment risk while a positive percentage change reflects an increase in entrainment risk.
Key:
AN = above-normal
BN = below-normal
C = critical
CP = Comprehensive Plan
D = dry
W = wet

Results of the entrainment risk calculations for delta smelt showed a change of less than 1 percent in wet, above-normal, and below-normal water years and an increase in risk of less than 3 percent during critical water years under CP5 relative to the Existing Condition (Table 11-59). The risk of increased losses of delta smelt under CP5 compared to the No-Action Alternative (Table 11-59) would be greatest in the below-normal water years. Although the incremental change in the risk of delta smelt losses resulting from CVP and SWP export operations is small, delta smelt population abundance is currently at such critically low levels that even a small increase in the risk of losses is considered to be potentially significant. The increase in risk would also contribute to cumulative factors affecting the survival of delta smelt.

The estimated change in the risk of losses for salmon increases during below-normal and critical water years under 2005 conditions, and above-normal and below-normal water years under 2030 conditions (Table 11-59). Given the numbers of juvenile Chinook salmon produced each year in the Central Valley, the relatively small incremental increase in the risk of entrainment/salvage at the CVP and SWP export facilities would be a less-than-significant direct impact but would contribute incrementally to the overall cumulative factors affecting juvenile Chinook salmon survival within the Delta, and population dynamics of the stocks.

The change in the risk of longfin smelt entrainment/salvage under CP5 compared to the No-Action Alternative and to the Existing Condition shows small positive and negative changes depending on water year type and alternative (Table 11-59). These small changes in the risk of entrainment would be less than significant in most water years. The estimated 3 percent increase in entrainment risk in critically dry years is potentially significant given the trend of low longfin smelt juvenile production in dry years.

The change in the risk to steelhead of entrainment/salvage at the CVP and SWP export facilities are summarized in Table 11-59. The small positive and negative changes in risk under wet, above-normal, below-normal, and dry water years are considered to be less than significant. The increase in risk of steelhead losses in critical water years are considered to be less than significant (less than 2 percent), but would contribute directly to cumulative factors affecting the survival and population dynamics of Central Valley steelhead. The predicted increase in potential entrainment risk for steelhead under critical water years represents an initial estimate of the change (percentage) between CP5 and Existing Conditions and the No-Action Alternative, and does not allow the predicted losses to be evaluated at the population level (see Attachment 1 of the *Fisheries and Aquatic Ecosystems Technical Report)*.

The estimated changes in risk to juvenile striped bass from entrainment/salvage at the CVP and SWP export facilities are summarized in Table 11-55. The change in risk in wet, above-normal, and below-normal water years are considered to be less than significant for striped bass, but would contribute to the cumulative factors affecting striped bass survival and population dynamics in the Delta. The losses of juvenile striped bass increased substantially under dry and critical water years, which would be expected with an increase in exports during the summer months and is considered to be a potentially significant impact. The increased losses under CP5, particularly in drier water years when juvenile striped bass production is lower, would be expected to contribute to the cumulative effects of factors affecting juvenile striped bass survival in the Delta.

The overall average increased risk index for splittail was less than 1 percent under both 2005 and 2030 conditions, and was considered to be less than significant. The loss index is, however, higher during dry and critical water years. Higher risk of entrainment/salvage losses in drier water years has a potentially greater effect of abundance of juvenile splittail since reproductive success and overall juvenile abundance is typically lower within the Delta in dry years. The increased risk of losses in drier years was considered to be potentially significant. The increased losses would also contribute to cumulative factors affecting survival of juvenile splittail within the Delta.

Impact Aqua-23 (CP5) is considered to be less than significant for Chinook salmon and steelhead, but potentially significant for delta smelt, longfin smelt, striped bass, and splittail. Mitigation for this impact is not proposed because operations will be guided by RPAs established by NMFS and USFWS BOs to reduce any impacts to listed fish species, thus reducing the impacts to non-listed fish species.

CVP/SWP Service Areas

Impact Aqua-24 (CP5): Impacts on Aquatic Habitats and Fish Populations in the CVP and SWP Service Areas Resulting from Modifications to Existing Flow Regimes Project implementation could result in modified flow regimes that would reduce the frequency and magnitude of high winter flows along the Sacramento River; however, the hydrologic effects to tributaries and reservoirs (e.g., New Melones and San Luis) from CVP and SWP dams, as well as the conveyances south of the Delta would be substantially less than impacts on the lower Sacramento River. The change in hydrology to the CVP and SWP service areas could affect aquatic habitats that provide habitat for the fish community; however these changes would not result in substantial effects on their distribution or abundance. Therefore, this impact would be less than significant.

This impact would be similar to Impact Aqua-24 (CP1). The hydrologic effects to the CVP and SWP service areas would not result in substantial effects on the distribution or abundance of the fish species. The effects from CP5 on CVP and SWP reservoir elevations, filling, spilling, and planned releases, and the resulting downstream flows, would be small and well within the range of variability that commonly occurs in these reservoirs and downstream flows. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

11.3.4 Mitigation Measures

Table 11-60 presents a summary of mitigation measures for fisheries and aquatic ecosystems.

No-Action Alternative

No mitigation measures are required for this alternative.

Table 11-60. Summary of Mitigation Measures for Fisheries and Aquatic Ecosystems

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/CP4A	CP5
Impact Aqua-1: Effects on Nearshore, Warm-Water Habitat in Shasta Lake from Project Operations	LOS before Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
Impact Aqua-2: Effects on Nearshore, Warm-Water Habitat in Shasta Lake from Project Construction	LOS before Mitigation	NI	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS
Impact Aqua-3: Effects on Cold-Water Habitat in Shasta Lake	LOS before Mitigation	PS	B	B	B	B	B
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	PS	B	B	B	B	B
Impact Aqua-4: Effects on Special-Status Aquatic Mollusks	LOS before Mitigation	LTS	PS	PS	PS	PS	PS
	Mitigation Measure	None required.		Mitigation Measure Aqua-4: Implement Mitigation Measure Geo-2: Replace Lost Ecological Functions of Aquatic Habitats by Restoring Existing Degraded Aquatic Habitats in the Vicinity of the Impact.			
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS

Table 11-60. Summary of Mitigation Measures for Fisheries and Aquatic Ecosystems (contd.)

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/CP4A	CP5
Impact Aqua-5: Effects on Special-Status Fish Species	LOS before Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.		None needed; thus, none proposed.			
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
Impact Aqua-6: Creation or Removal of Barriers to Fish Between Tributaries and Shasta Lake	LOS before Mitigation	NI	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.		None needed; thus, none proposed.			
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS
Impact Aqua-7: Effects on Spawning and Rearing Habitat of Adfluvial Salmonids in Low-Gradient Tributaries to Shasta Lake	LOS before Mitigation	NI	PS	PS	PS	PS	PS
	Mitigation Measure	None required.	Mitigation Measure Aqua-7: Implement Mitigation Measure Geo-2: Replace Lost Ecological Functions of Aquatic Habitats by Restoring Existing Degraded Aquatic Habitats in the Vicinity of the Impact.				None required.
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS
Impact Aqua-8: Effects on Aquatic Connectivity in Non-Fish-Bearing Tributaries to Shasta Lake	LOS before Mitigation	NI	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.		None needed; thus, none proposed.			
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS

Table 11-60. Summary of Mitigation Measures for Fisheries and Aquatic Ecosystems (contd.)

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/CP4A	CP5
Impact Aqua-9: Effects on Water Quality at Livingston Stone Hatchery	LOS before Mitigation	NI	NI	NI	NI	NI	NI
	Mitigation Measure	None required.		None needed; thus, none proposed.			
	LOS after Mitigation	NI	NI	NI	NI	NI	NI
Impact Aqua-10: Loss or Degradation of Aquatic Habitat in the Upper Sacramento River During Construction Activities	LOS before Mitigation	NI	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.		None needed; thus, none proposed.			
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS
Impact Aqua-11: Release and Exposure of Contaminants in the Upper Sacramento River During Construction Activities	LOS before Mitigation	NI	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.		None needed; thus, none proposed.			
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS
Impact Aqua-12: Changes in Flow and Water Temperature in the Upper Sacramento River Resulting from Project Operation – Chinook Salmon and Steelhead	LOS before Mitigation	PS	LTS	B	B	B	B
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	PS	LTS	B	B	B	B

Table 11-60. Summary of Mitigation Measures for Fisheries and Aquatic Ecosystems (contd.)

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/CP4A	CP5
Impact Aqua-13: Changes in Flow and Water Temperature in the Upper Sacramento River Resulting from Project Operation – Steelhead, Green Sturgeon, Sacramento Splittail, American Shad, and Striped Bass	LOS before Mitigation	PS	LTS	LTS	LTS	B	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	PS	LTS	LTS	LTS	B	LTS
Impact Aqua-14: Reduction in Ecologically Important Geomorphic Processes in the Upper Sacramento River Resulting from Reduced Frequency and Magnitude of Intermediate to High Flows	LOS before Mitigation	NI	PS	PS	PS	PS	PS
	Mitigation Measure	None required.	Mitigation Measure Aqua-14: Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities.				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS
Impact Aqua-15: Changes in Flow and Water Temperatures in the Lower Sacramento River and Tributaries and Trinity River Resulting from Project Operation – Fish Species of Primary Management Concern	LOS before Mitigation	NI	PS	PS	PS	PS	PS
	Mitigation Measure	None required.	Mitigation Measure Aqua-15: Maintain Flows in the Feather River, American River, and Trinity River Consistent with Existing Regulatory and Operational Requirements and Agreements.				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS

Table 11-60. Summary of Mitigation Measures for Fisheries and Aquatic Ecosystems (contd.)

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/CP4A	CP5
Impact Aqua-16: Reduction in Ecologically Important Geomorphic Processes in the Lower Sacramento River Resulting from Reduced Frequency and Magnitude of Intermediate to High Flows	LOS before Mitigation	NI	PS	PS	PS	PS	PS
	Mitigation Measure	None required.	Mitigation Measure Aqua-16: Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities.				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS
Impact Aqua-17: Effects to Delta Fisheries Resulting from Changes to Delta Outflow	LOS before Mitigation	NI	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS
Impact Aqua-18: Effects to Delta Fisheries Resulting from Changes to Delta Inflow	LOS before Mitigation	NI	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS
Impact Aqua-19: Effects to Delta Fisheries Resulting from Changes in Sacramento River Inflow	LOS before Mitigation	NI	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS

Table 11-60. Summary of Mitigation Measures for Fisheries and Aquatic Ecosystems (contd.)

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/CP4A	CP5
Impact Aqua-20: Effects to Delta Fisheries Resulting from Changes in San Joaquin River Flow at Vernalis	LOS before Mitigation	NI	NI	NI	NI	NI	NI
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	NI	NI	NI	NI	NI	NI
Impact Aqua-21: Reduction in Low-Salinity Habitat Conditions Resulting from an Upstream Shift in X2 Location	LOS before Mitigation	NI	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS
Impact Aqua-22: Increase in Mortality of Species of Primary Management Concern as a Result of Increased Reverse Flows in Old and Middle Rivers	LOS before Mitigation	NI	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS
Impact Aqua-23: Increase in the Risk of Entrainment or Salvage of Species of Primary Management Concern at CVP and SWP Export Facilities Due to Changes in CVP and SWP Exports	LOS before Mitigation	NI	PS	PS	PS	PS	PS
	Mitigation Measure	None required.	None proposed because operations will be guided by RPAs established by NMFS and USFWS BOs to reduce any impacts to listed fish species, and thus reduce impacts to non-listed fish species				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS

Table 11-60. Summary of Mitigation Measures for Fisheries and Aquatic Ecosystems (contd.)

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/CPA4	CP5
Impact Aqua-24: Impacts on Aquatic Habitats and Fish Populations in the CVP and SWP Service Areas Resulting from Modifications to Existing Flow Regimes	LOS before Mitigation	NI	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS

Key:
B = beneficial
BO = Biological Opinion
CP = Comprehensive Plan
CVP = Central Valley Project
LOS = level of significance
LTS = less than significant
NI = No Impact
NMFS = National Marine Fisheries Service
PS = potentially significant
RPA = Reasonable and Prudent Alternative
S = significant
SWP = State Water Project
USFWS = U.S. Fish and Wildlife Service

CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

No mitigation is required for Impacts Aqua-1 (CP1) through Aqua-3 (CP1), Impacts Aqua-5 (CP1) and Aqua-6 (CP1), Impacts Aqua-8 (CP1) through Aqua-13 (CP1), or Impacts Aqua-17 through Aqua-21 (CP1). No mitigation is proposed for Impact Aqua-22 (CP1) or Impact Aqua-23 (CP1) because operations will be guided by RPAs established by NMFS and USFWS BOs, which should reduce impacts to listed and non-listed fish species. Mitigation measures are provided below for other impacts of CP1 on fisheries and aquatic ecosystems.

Mitigation Measure Aqua-4 (CP1): Implement Mitigation Measure Geo-2 (CP1): Replace Lost Ecological Functions of Aquatic Habitats by Restoring Existing Degraded Aquatic Habits in the Vicinity of the Impact The loss of 18.5 miles of intermittent and perennial streams (including 6.2 miles of streams with a gradient less than 7 percent) will be mitigated by compensating for the impact by replacing or providing substitute resources or environments. As described in Preliminary Environmental Commitments and Mitigation Plan Appendix, Reclamation convened an interagency working group to enhance mitigation measures presented in the DEIS. The environmental commitments described in Chapter 2, "Alternatives," of the EIS and the Preliminary Environmental Commitments and Mitigation Plan Appendix are intended to address impacts to channels within the existing drawdown zone (1070 msl).

An outcome of the interagency work group discussions was the agreement that this mitigation measure would encompass efforts within the channels actually affected by the comprehensive plan, but would also be expanded to restore degraded aquatic habitat in channels upstream from Shasta Lake. In general, this mitigation measure would follow the approach to characterize, prioritize, and identify specific restoration actions described in the *California Salmonid Stream Habitat Restoration Manual – Fourth Edition* (DFG 2010).

For CP1, this mitigation measure would result in result in restoration of up to 18.5 miles of channel, with an emphasis on low-gradient perennial channels to be identified by an interagency work group to be convened by Reclamation. This mitigation focuses on restoring and enhancing the aquatic functions of existing, degraded aquatic habitats in or near reaches within the proposed inundation zone and upstream reaches.

The interagency working group would focus on identification of specific tributaries to Shasta Lake that may benefit from various mitigation techniques using available information. Examples of techniques that may be used include channel and bank stabilization, channel redirection, channel reconstruction, culvert replacement and elimination of barriers to fish passage, and enhancement of habitat physical structure (e.g., placement of woody debris, rocks). The nature and extent of the restoration and enhancement activities will be based on an assessment of the ecological functions that are lost as a consequence of implementing the alternative. Implementation of this mitigation measure would reduce Impact Aqua-4 (CP1) to a less-than-significant level.

Mitigation Measure Aqua-7 (CP1): Implement Mitigation Measure Aqua-4 (CP1): Replace Lost Ecological Functions of Aquatic Habitats by Restoring Existing Degraded Aquatic Habits in the Vicinity of the Impact This mitigation measure is the same as Mitigation Measure Aqua-4 (CP1). Implementation of this mitigation measure would reduce Impact Aqua-7 (CP1) to a less-than-significant level.

Mitigation Measure Aqua-14 (CP1): Implement Mitigation Measure Bot-7 (CP1): Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities This measure is identical to Mitigation Measure Bot-7 (CP1), described in Chapter 12, "Botanical Resources and Wetlands." Implementation of this mitigation measure would reduce Impact Aqua-14 (CP1) to a less-than-significant level.

Mitigation Measure Aqua-15 (CP1): Maintain Flows in the Feather River, American River, and Trinity River Consistent with Existing Regulatory and Operational Requirements and Agreements Flows in the Feather, American, and Trinity rivers will be maintained pursuant to existing operational agreements, BOs, criteria, and standards that are protective of fisheries resources. Implementation of this measure would reduce Impact Aqua-15 (CP1) to a less-than-significant level.

Mitigation Measure Aqua-16 (CP1): Implement Mitigation Measure Bot-7(CP1): Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities This measure is identical to Mitigation Measure Bot-7 (CP1), described in Chapter 12, "Botanical Resources and Wetlands." Implementation of this mitigation measure would reduce Impact Aqua-16 (CP1) to a less-than-significant level.

CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

No mitigation is required for Impacts Aqua-1 (CP2) through Aqua-3 (CP2), Impacts Aqua-5 (CP2) and Aqua-6 (CP2), Impacts Aqua-8 (CP2) through Aqua-13 (CP2), or Impacts Aqua-17 (CP2) through Aqua-21 (CP2). No mitigation is proposed for Impact Aqua-22 (CP2) or Impact Aqua-23 (CP2) because operations will be guided by RPAs established by NMFS and USFWS BOs, which should reduce impacts to listed and non-listed fish species. Mitigation measures are provided below for other impacts of CP2 on fisheries and aquatic ecosystems.

Mitigation Measure Aqua-4 (CP2): Implement Mitigation Measure Geo-2 (CP2): Replace Lost Ecological Functions of Aquatic Habitats by Restoring Existing Degraded Aquatic Habitats in the Vicinity of the Impact This mitigation measure is the same as Mitigation Measure Geo-2 (CP2) described in Chapter 4, "Geology, Geomorphology, Minerals, and Soils." The loss of 25.5 miles of intermittent and perennial streams (including 8.2 miles of streams with a gradient less than 7 percent) will be mitigated by compensating for the impact by replacing or providing substitute resources or environments. Compensation will be accomplished by restoring and enhancing the aquatic functions of existing, degraded aquatic habitats in or near the Shasta Lake and vicinity area. Examples of techniques that may be used include channel and bank stabilization, channel redirection, channel reconstruction, culvert replacement and elimination of barriers to fish passage, and enhancement of habitat physical structure (e.g., placement of woody debris, rocks). The nature and extent of the restoration and enhancement activities will be based on an assessment of the ecological functions that are lost as a consequence of implementing this alternative. Implementation of this mitigation measure would reduce Impact Aqua-4 (CP2) to a less-than-significant level.

Mitigation Measure Aqua-7 (CP2): Implement Mitigation Measure Aqua-4 (CP2): Replace Lost Ecological Functions of Aquatic Habitats by Restoring Existing Degraded Aquatic Habitats in the Vicinity of the Impact This mitigation measure is the same as Mitigation Measure Aqua-4 (CP2). Implementation of this mitigation measure would reduce Impact Aqua-7 (CP2) to a less-than-significant level.

Mitigation Measure Aqua-14 (CP2): Implement Mitigation Measure Bot-7(CP2): Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities This measure is identical to Mitigation Measure Bot-7 (CP2), described in Chapter 12, "Botanical Resources and Wetlands." Implementation of this mitigation measure would reduce Impact Aqua-14 (CP2) to a less-than-significant level.

Mitigation Measure Aqua-15 (CP2): Maintain Flows in the Feather River, American River, and Trinity River Consistent with Existing Regulatory and Operational Requirements and Agreements Flows in the Feather, American, and Trinity rivers will be maintained pursuant to existing operational agreements, BOs, criteria, and standards that are protective of fisheries resources. Implementation of this measure would reduce Impact Aqua-15 (CP2) to a less-than-significant level.

Mitigation Measure Aqua-16 (CP2): Implement Mitigation Measure Bot-7(CP2): Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities This measure is identical to Mitigation Measure Bot-7 (CP2), described in Chapter 12, "Botanical Resources and Wetlands." The riverine ecosystem mitigation and adaptive management plan will include mitigation measures from Shasta Dam downstream to Colusa (RM 144). The plan will be developed and implemented before project construction, and will be consistent with and will support implementation of the Senate Bill 1086 program. The plan will also be developed in coordination with USFWS, NMFS, CDFW, and the SRCA Forum. One of the goals of the plan will be to ensure that project implementation results in no net reduction in the amount (i.e., frequency and magnitude) of overbank inundation; this includes inundation of floodplains and bypasses. Therefore, implementation of this mitigation measure would reduce Impact Aqua-16 (CP2) to a less-than-significant level.

CP3 – 18.5-Foot Dam Raise, Agricultural Water Supply Reliability and Anadromous Fish Survival

No mitigation is required for Impacts Aqua-1 (CP3) through Aqua-3 (CP3), Impacts Aqua-5 (CP3) and Aqua-6 (CP3), Impacts Aqua-8 (CP3) through Aqua-13 (CP3), or Impacts Aqua-17 (CP3) through Aqua-21 (CP3). No mitigation is proposed for Impact Aqua-22 (CP3) or Impact Aqua-23 (CP3) because operations will be guided by RPAs established by NMFS and USFWS BOs, which should reduce impacts to listed and non-listed fish species. Mitigation measures are provided below for other impacts of CP3 on fisheries and aquatic ecosystems.

Mitigation Measure Aqua-4 (CP3): Implement Mitigation Measure Geo-2 (CP3): Replace Lost Ecological Functions of Aquatic Habitats by Restoring Existing Degraded Aquatic Habitats in the Vicinity of the Impact This mitigation measure is the same as Mitigation Measure Geo-2 (CP3) described in Chapter 4, "Geology, Geomorphology, Minerals, and Soils." The loss of 36.5 miles of intermittent and perennial streams (including 12.1 miles of streams with a gradient less than 7 percent) will be mitigated by compensating for the impact by replacing or providing substitute resources or environments. Compensation will be accomplished by restoring and enhancing the aquatic functions of existing, degraded aquatic habitats in or near the Shasta Lake and vicinity area. Examples of techniques that may be used include channel and bank stabilization, channel redirection, channel reconstruction, culvert replacement and elimination of barriers to fish passage, and enhancement of habitat physical structure (e.g., placement of woody debris, rocks). The nature and extent of the restoration and enhancement activities will be based on an assessment of the ecological functions that are lost as a consequence of implementing this alternative. Implementation of this mitigation measure would reduce Impact Aqua-4 (CP3) to a less-than-significant level.

Mitigation Measure Aqua-7 (CP3): Implement Mitigation Measure Aqua-4 (CP3): Replace Lost Ecological Functions of Aquatic Habitats by Restoring Existing Degraded Aquatic Habitats in the Vicinity of the Impact This mitigation measure is the same as Mitigation Measure Aqua-4 (CP3).

Implementation of this mitigation measure would reduce Impact Aqua-7 (CP3) to a less-than-significant level.

Mitigation Measure Aqua-14 (CP3): Implement Mitigation Measure Bot-7 (CP3): Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities This measure is identical to Mitigation Measure Bot-7 (CP3), described in Chapter 12, "Botanical Resources and Wetlands." Implementation of this mitigation measure would reduce Impact Aqua-14 (CP3) to a less-than-significant level.

Mitigation Measure Aqua-15 (CP3): Maintain Flows in the Feather River, American River, and Trinity River Consistent with Existing Regulatory and Operational Requirements and Agreements Flows in the Feather, American, and Trinity rivers will be maintained pursuant to existing operational agreements, BOs, criteria, and standards that are protective of fisheries resources. Implementation of this measure would reduce Impact Aqua-15 (CP3) to a less-than-significant level.

Mitigation Measure Aqua-16 (CP3): Implement Mitigation Measure Bot-7 (CP3): Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities This measure is identical to Mitigation Measure Bot-7 (CP3), described in Chapter 12, "Botanical Resources and Wetlands." Implementation of this measure would reduce Impact Aqua-16 (CP3) to a less-than-significant level.

CP4 and CP4A – 18.5-Foot Dam Raise, Anadromous Fish Focus with Water Supply Reliability

No mitigation is required for Impacts Aqua-1 (CP4/CP4A) through Aqua-3 (CP4/CP4A), Impacts Aqua-5 (CP4/CP4A) and Aqua-6 (CP4/CP4A), Impacts Aqua-8 (CP4) through Aqua-13 (CP4), or Impacts Aqua-17 (CP4/CP4A) through Aqua-21 (CP4/CP4A). No mitigation is proposed for Impact Aqua-22 (CP4/CP4A) or Impact Aqua-23 (CP4/CP4A) because operations will be guided by RPAs established by NMFS and USFWS BOs, which should reduce impacts to listed and non-listed fish species. Mitigation measures are provided below for other impacts of CP4 or CP4A on fisheries and aquatic ecosystems.

Mitigation Measure Aqua-4 (CP4 or CP4A): Implement Mitigation Measure Geo-2 (CP4 or CP4A): Replace Lost Ecological Functions of Aquatic Habitats by Restoring Existing Degraded Aquatic Habitats in the Vicinity of the Impact This mitigation measure is the same as Mitigation Measure Geo-2 (CP3) described in Chapter 4, "Geology, Geomorphology, Minerals, and Soils." The loss of 36.5 miles of intermittent and perennial streams (including 12.1 miles of streams with a gradient less than 7 percent) will be mitigated by compensating for the impact by replacing or providing substitute resources or environments. Compensation will be accomplished by restoring and enhancing the aquatic functions of existing, degraded aquatic habitats in or near the Shasta Lake and vicinity area. Examples of techniques that may be used include channel and bank stabilization, channel redirection, channel reconstruction, culvert replacement and elimination of barriers to fish passage, and enhancement of habitat physical structure (e.g., placement of woody debris, rocks). The nature and extent of the restoration and enhancement activities will be based on an assessment of the ecological functions that are lost as a consequence of implementing this alternative. Implementation of this mitigation measure would reduce Impact AQUA-4 (CP4 and CP4A) to a less-than-significant level.

Mitigation Measure Aqua-7 (CP4 or CP4A): Implement Mitigation Measure Aqua-4 (CP4 or CP4A): Replace Lost Ecological Functions of Aquatic Habitats by Restoring Existing Degraded Aquatic Habitats in the Vicinity of the Impact This mitigation measure is the same as Mitigation Measure Aqua-4. Implementation of this mitigation measure would reduce Impact Aqua-7 (CP4 or CP4A) to a less-than-significant level.

Mitigation Measure Aqua-14 (CP4 or CP4A): Implement Mitigation Measure Bot-7 (CP1): Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities This measure is identical to Mitigation Measure Bot-7 (CP4 or CP4A), described in Chapter 12, “Botanical Resources and Wetlands.” Implementation of this mitigation measure would reduce Impact Aqua-14 (CP4 or CP4A) to a less-than-significant level.

Mitigation Measure Aqua-15 (CP4 or CP4A): Maintain Flows in the Feather River, American River, and Trinity River Consistent with Existing Regulatory and Operational Requirements and Agreements Flows in the Feather, American, and Trinity rivers will be maintained pursuant to existing operational agreements, BOs, criteria, and standards that are protective of fisheries resources. Implementation of this measure would reduce Impact Aqua-15 (CP4 or CP4A) to a less-than-significant level.

Mitigation Measure Aqua-16 (CP4 or CP4A): Implement Mitigation Measure Bot-7 (CP1): Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities This measure is identical to Mitigation Measure Bot-7 (CP1), described in Chapter 12, “Botanical Resources and Wetlands.” Implementation of this measure would reduce Impact Aqua-16 (CP4 or CP4A) to a less-than-significant level.

CP5 – 18.5-Foot Dam Raise, Combination Plan

No mitigation is required for Impacts Aqua-1 (CP5) through Aqua-3 (CP5), Impacts Aqua-5 (CP5) through Aqua-13 (CP5), or Impacts Aqua-17 (CP5) through Aqua-21 (CP5). No mitigation is proposed for Impact Aqua-22 (CP5) or Impact Aqua-23 (CP5) because operations will be guided by RPAs established by NMFS and USFWS BOs, which should reduce impacts to listed and non-listed fish species. Mitigation measures are provided below for the other impacts of CP5 on fisheries and aquatic ecosystems.

Mitigation Measure Aqua-4 (CP5): Implement Mitigation Measure Geo-2 (CP5): Replace Lost Ecological Functions of Aquatic Habitats by Restoring Existing Degraded Aquatic Habitats in the Vicinity of the Impact This mitigation measure is the same as Mitigation Measure Geo-2 (CP3) described in Chapter 4, “Geology, Geomorphology, Minerals, and Soils.” The loss of 36.5 miles of intermittent and perennial streams (including 12.1 miles of streams with a gradient less than 7 percent) will be mitigated by compensating for the impact by replacing or providing substitute resources or environments. Compensation will be accomplished by restoring and enhancing the aquatic functions of existing, degraded aquatic habitats in or near the Shasta Lake and vicinity area. Examples of techniques that may be used include channel and bank stabilization, channel redirection, channel reconstruction, culvert replacement and elimination of barriers to fish passage, and enhancement of habitat physical structure (e.g., placement of woody debris, rocks). The nature and extent of the restoration and enhancement activities will be based on an assessment of the ecological functions that are lost as a consequence of implementing this alternative. Implementation of this mitigation measure would reduce Aqua-4 (CP5) to a less-than-significant level.

Mitigation Measure Aqua-7 (CP5): Implement Mitigation Measure Aqua-4 (CP5): Replace Lost Ecological Functions of Aquatic Habitats by Restoring Existing Degraded Aquatic Habitats in the Vicinity of the Impact This mitigation measure is the same as Mitigation Measure Aqua-4. Implementation of this mitigation measure would reduce Impact Aqua-7 (CP5) to a less-than-significant level.

Mitigation Measure Aqua-14 (CP5): Implement Mitigation Measure Bot-7 (CP3): Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities This measure is identical to Mitigation Measure Bot-7 (CP3), described in Chapter 12, “Botanical Resources and Wetlands.” Implementation of this mitigation measure would reduce Impact Aqua-14 (CP5) to a less-than-significant level.

Mitigation Measure Aqua-15 (CP5): Maintain Flows in the Feather River, American River, and Trinity River Consistent with Existing Regulatory and Operational Requirements and Agreements Flows in the Feather, American, and Trinity rivers will be maintained pursuant to existing operational agreements, BOs, criteria, and standards that are protective of fisheries resources. Implementation of this measure would reduce Impact Aqua-15 (CP5) to a less-than-significant level.

Mitigation Measure Aqua-16 (CP5): Implement Mitigation Measure Bot-7 (CP3): Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities This measure is identical to Mitigation Measure Bot-7 (CP3), described in Chapter 12, "Botanical Resources and Wetlands." Implementation of this measure would reduce Impact Aqua-16 (CP5) to a less-than-significant level.

11.3.5 Cumulative Effects

Chapter 3, "Considerations for Describing the Affected Environment and Environmental Consequences," discusses overall cumulative impacts methodology related to the action alternatives, including the relationship to the CALFED Bay-Delta Program Programmatic EIS/EIR cumulative impacts analysis, qualitative and quantitative assessment, past and future actions in the study area, and significance criteria. Table 3-1, "Present and Reasonably Foreseeable Future Actions Included in the Analysis of Cumulative Impacts, by Resource Area," in Chapter 3, lists the projects considered quantitatively and qualitatively within the cumulative impacts analysis. This cumulative impacts analysis accounts for potential project impacts combined with the impacts of existing facilities, conditions, land uses, and reasonably foreseeable actions expected to occur in the study area on a qualitative and quantitative level.

As described in Section 11.1, "Affected Environment," aquatic habitats within the primary and extended study areas historically contained large populations of anadromous and other native fish species. Water supply projects, urban development, pollution, and flood control modifications have resulted in altered and degraded habitat conditions and reduced this historical fishery throughout the primary and extended study areas. The combined effects of past and present projects have resulted in a significant adverse cumulative impact on fisheries and aquatic ecosystems of the Sacramento River and its watershed.

Many of the reasonably foreseeable future projects identified in Chapter 3 (see Table 3-1) under the Quantitative Analysis would involve changes to SWP and CVP water operations downstream from Shasta Dam. Also, projects listed in Table 3-1 under Qualitative Analysis would result in potential changes such as changes to operations of hydroelectric projects upstream from Shasta Dam, which would in turn be anticipated to affect fisheries and aquatic ecosystems. Example projects from Table 3-1 that may contribute to cumulative impacts include, but are not limited to, the CVPIA; Clear Creek Actions of the AFRP; CALFED ERP; BDCP; Fish Passage Programs at Shasta, Folsom, and Yuba Rivers; and the San Joaquin River Restoration Program. While some of these changes could result in beneficial effects compared to current conditions, aquatic habitat and fisheries resources would remain limited due to continuing effects from blockage of upstream fish habitat, blockage of spawning gravels, mortality due to water diversions, habitat alterations caused by large-scale modifications to hydrology (hydromodification), and high water temperatures due to lack of riparian vegetation and hydromodification.

The effects of climate change during this century on operations at Shasta Lake and downstream and upstream from the dam, could result in changes to water temperature, flow, and ultimately, fish populations under the No-Action Alternative. As described in the Climate Change Modeling Appendix, climate change could result in increased inflows to Shasta Lake and higher reservoir releases in the future due to an increase in winter and early spring inflow into the lake from high-intensity storm events. The change in reservoir releases could be necessary to manage flood events resulting from these potentially larger storms. Climate change could also result in reduced-end-of September carryover storage volumes, resulting in lower lake levels for a portion of the year, and a smaller cold-water pool resulting in warmer water temperature and reduced water quality within Shasta Reservoir. Most importantly, it is expected that climate change will result in increased water temperatures downstream from Shasta Dam, particularly in summer months, and more frequent wet and drought (particularly extended drought) years. The increased water temperatures, and greater inter-annual precipitation variability will compound the threats to fish (especially anadromous fish) in the Sacramento River. Winter-run Chinook salmon are particularly vulnerable to climate warming, prolonged droughts, and other catastrophic environmental events because they have only one remaining population that spawns during the summer months, when water temperature increases are expected to be the largest (NMFS 2009, 2014). Additionally, ocean productivity is expected to decline from altered upwelling cycles. This could reduce the available food resources for ocean-rearing salmonids and sturgeon, impacting fish survival.

Climate change is also expected to result in sea-level rise during this century, which will have effects on Delta salinity levels due to greater tidal excursion. This in turn will affect the location of X2 (2 parts per thousand salinity concentration) position from February through June, moving X2 upstream, which will have adverse effects to native species in the Delta under the No-Action Alternative.

The following analysis evaluates the potential cumulative impacts on fisheries and aquatic ecosystems when considering the project alternatives in combination with other past, present, and reasonably foreseeable future projects.

CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

As described in Section 11.3.3, “Direct and Indirect Effects,” without mitigation, CP1 could cause potentially significant effects on vegetation and habitats and special-status species in the primary and extended study areas. These effects would be caused by the loss or degradation of aquatic habitats in the primary study area, or by alteration of the flow regime of the Sacramento

River downstream from Keswick Dam and associated geomorphic processes in the primary and extended study areas.

Given the scale and duration of the project construction activities associated with CP1, the contribution of CP1 to construction-related cumulative impacts on fisheries and aquatic ecosystems would be cumulatively considerable. CP1 would be undertaken in accordance with a project-specific SWPPP as reviewed and approved by the CVRWQCB. The SWPPP would require implementation of extensive BMPs during project construction, as well as postconstruction site restoration and stabilization to control erosion and sedimentation and to prevent the discharge of pollutants into the Sacramento River and other waterways. Implementation of these measures would reduce the project's contribution to cumulative construction-related impacts to a less-than-significant level.

Given major past alterations to the Sacramento River's aquatic ecosystem and associated aquatic habitats, the contributing adverse effects from CP1 would be cumulatively considerable; specifically, (1) additional inundation of potential riverine habitat for special-status mollusk species above Shasta Lake, (2) additional inundation of cold-water riverine spawning and rearing habitat above Shasta Lake, and (3) reduction of the magnitude and frequency of flows for ecologically important geomorphic processes in the upper and lower Sacramento River below Shasta Dam. With implementation of Mitigation Measure Aqua-4 (CP1) (focused on Shasta Lake and vicinity) and Mitigation Measures Aqua-14 (CP1) through Aqua-16 (CP1) (focused on the Sacramento River downstream from Shasta Lake), adverse effects from CP1 would be reduced and would no longer result in a cumulatively considerable incremental contribution to significant cumulative effects on these resources.

As stated previously, effects of climate change on operations of Shasta Lake could include increased inflows and releases at certain times of the year, and decreased inflows at other times. The additional storage associated with CP1 would potentially reduce these effects and allow Shasta Lake to capture some of the increased runoff in the winter and early spring for release in late spring and summer. More importantly, an increased cold-water pool volume will allow Shasta Lake to be managed to provide cooler water releases downstream during critical life stages, particularly for Chinook spawning. Additionally, habitat for both warm- and cold-water reservoir fisheries would be increased with an enlarged reservoir area. Under CP1, potential impacts to Sacramento River fish downstream from Shasta Dam would be beneficial.

Modeling conducted for the Climate Change Modeling Appendix was inconclusive about the effects of this alternative on Delta salinity. If exports are increased under this alternative, it could have an adverse effect on the location of X2, when considered along with other potential projects. However, if the location of X2 remains a water quality and regulatory requirement, then additional exports would not occur when X2 compliance would be violated. Therefore, no cumulative impact on X2 will occur under this alternative.

CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

The cumulative effects of CP2 on special-status mollusks above Shasta Dam, cold-water fish spawning and rearing habitat above Shasta Dam, and ecologically important geomorphic processes below Shasta Dam would be associated with mechanisms similar to those of CP1. However, the magnitude of these impacts would be greater, in many cases, because of the greater inundation area and greater effects increased storage volume on the timing, magnitude, and duration of flows downstream than would occur under CP1.

Given the scale and duration of the project construction activities associated with CP2, the contribution of CP2 to construction-related cumulative impacts on fisheries and aquatic ecosystems would be cumulatively considerable. CP2 would be undertaken in accordance with a project-specific SWPPP as reviewed and approved by the CVRWQCB. The SWPPP would require implementation of extensive BMPs during project construction, as well as post construction site restoration and stabilization to control erosion and sedimentation and to prevent the discharge of pollutants into the Sacramento River and other waterways. Implementation of these measures would reduce the project’s contribution to cumulative construction-related impacts to a less-than-significant level.

Given major past alterations to the Sacramento River’s aquatic ecosystem and associated aquatic habitats, the contributing adverse effects from CP2 would be cumulatively considerable; specifically, (1) additional inundation of potential riverine habitat for special-status mollusk species above Shasta Dam, (2) additional inundation of cold-water riverine fish spawning and rearing habitat above Shasta Dam, and (3) reduction of the magnitude and frequency of flows for ecologically important geomorphic processes in the upper and lower Sacramento River below Shasta Dam. With implementation of Mitigation Measure Aqua-4 (CP2) (focused on Shasta Lake and vicinity) and Mitigation Measures Aqua-14 through Aqua-16 (CP2) (focused on the Sacramento River downstream from Shasta Lake), adverse effects from CP2 would be further reduced, in combination with the downstream geomorphic restoration program elements, and would no longer result in a cumulatively considerable incremental contribution to significant cumulative effects on these resources.

As stated previously, effects of climate change on operations of Shasta Lake could include increased inflows and releases at certain times of the year, and decreased inflows at other times. The additional storage associated with CP2 would potentially reduce these effects and allow Shasta Lake to capture some of the increased runoff in the winter and early spring for release in late spring and summer. More importantly, an increased cold-water pool volume will allow Shasta Lake to be managed to provide cooler water releases downstream during critical life stages, particularly for Chinook spawning. Additionally, habitat for both warm- and cold-water reservoir fisheries would be increased with an enlarged reservoir area. Under CP2, potential impacts to Sacramento River fish below Shasta Dam would be beneficial.

Modeling conducted for the Climate Change Modeling Appendix was inconclusive about the effects of this alternative on Delta salinity. If exports are increased under this alternative, it could have an adverse effect on the location of X2, when considered along with other potential projects. However, if the location of X2 remains a water quality and regulatory requirement, then additional exports would not occur when X2 compliance would be violated. Therefore, no cumulative impact on X2 will occur under this alternative.

CP3 – 18.5-Foot Dam Raise, Agricultural Water Supply Reliability and Anadromous Fish Survival

The cumulative effects of CP3 on special-status mollusks above Shasta Dam, cold-water fish spawning and rearing habitat above Shasta Dam, and ecologically important geomorphic processes below Shasta Dam would be associated with mechanisms similar to those of CP1 and CP2. However, the magnitude of these impacts would be greater, in many cases, because of the greater inundation area and greater effects increased storage volume on the timing, magnitude, and duration of flows downstream than would occur under CP1 and CP2.

Given the scale and duration of the project construction activities associated with CP3, the contribution of CP3 to construction-related cumulative impacts on fisheries and aquatic ecosystems would be cumulatively considerable. CP3 would be undertaken in accordance with a project-specific SWPPP as reviewed and approved by the CVRWQCB. The SWPPP would require implementation of extensive BMPs during project construction, as well as postconstruction site restoration and stabilization to control erosion and sedimentation and to prevent the discharge of pollutants into the Sacramento River and other waterways. Implementation of these measures would reduce the project's contribution to cumulative construction-related impacts to a less-than-significant level.

Given major past alterations to the Sacramento River's aquatic ecosystem and associated aquatic habitats, the contributing adverse effects from CP3 would be cumulatively considerable; specifically, (1) additional inundation of potential riverine habitat for special-status mollusk species above Shasta Dam, (2) additional inundation of cold-water riverine fish spawning and rearing habitat above Shasta Dam, and (3) reduction of the magnitude and frequency of flows for ecologically important geomorphic processes in the upper and lower Sacramento River below Shasta Dam. With implementation of Mitigation Measure Aqua-4 (CP3) (focused on Shasta Lake and vicinity) and Mitigation Measures Aqua-14 (CP3) through Aqua-16 (CP3) (focused on the Sacramento River downstream from Shasta Lake), adverse effects from CP3 would be further reduced, in combination with the downstream geomorphic restoration program elements, and would no longer result in a cumulatively considerable incremental contribution to significant cumulative effects on these resources.

As stated previously, effects of climate change on operations of Shasta Lake could include increased inflows and releases at certain times of the year, and decreased inflows at other times. The additional storage associated with CP3 would potentially reduce these effects and allow Shasta Lake to capture some of the increased runoff in the winter and early spring for release in late spring and summer. More importantly, an increased cold-water pool volume will allow Shasta Lake to be managed to provide cooler water releases downstream during critical life stages, particularly for Chinook salmon. Additionally, habitat for both warm- and cold-water reservoir fisheries would be increased with an enlarged reservoir area. Under CP3, potential impacts to Sacramento River fish below Shasta Dam would be beneficial.

Modeling conducted for the Climate Change Modeling Appendix was inconclusive about the effects of this alternative on Delta salinity. If exports are increased under this alternative, it could have an adverse effect on the location of X2, when considered along with other potential projects. However, if the location of X2 remains a water quality and regulatory requirement, then additional exports would not occur when X2 compliance would be violated. Therefore, no cumulative impact on X2 will occur under this alternative.

CP4 and CP4A – 18.5-Foot Dam Raise, Anadromous Fish Focus with Water Supply Reliability

The cumulative effects of CP4 or CP4A on special-status mollusks above Shasta Dam, cold-water fish spawning and rearing habitat above Shasta Dam, and ecologically important geomorphic processes below Shasta Dam would be associated with mechanisms similar to those of CP1, CP2, and CP3. However, the magnitude of these impacts would be greater, in many cases, because of the greater inundation area and greater effects increased storage volume on the timing, magnitude, and duration of flows downstream than would occur under CP1 and CP2, but similar to CP3. Some of these impacts would be partially offset with the implementation of the gravel augmentation program, floodplain and riparian restoration at six potential sites along the Sacramento River between Keswick Dam and Red Bluff, and cold-water supply for anadromous fish management.

Given the scale and duration of the project construction activities associated with CP4 or CP4A, the contribution of CP4 or CP4A to construction-related cumulative impacts on fisheries and aquatic ecosystems would be cumulatively considerable. CP4 would be undertaken in accordance with a project-specific SWPPP as reviewed and approved by the CVRWQCB. The SWPPP would require implementation of extensive BMPs during project construction, as well as postconstruction site restoration and stabilization to control erosion and sedimentation and to prevent the discharge of pollutants into the Sacramento River and other waterways. Implementation of these measures would reduce the project's contribution to cumulative construction-related impacts to a less-than-significant level.

Given major past alterations to the Sacramento River's aquatic ecosystem and associated aquatic habitats, the contributing adverse effects from CP4 or CP4A would be cumulatively considerable; specifically, (1) additional inundation of potential riverine habitat for special-status mollusk species above Shasta Dam, (2) additional inundation of cold-water riverine fish spawning and rearing habitat above Shasta Dam, and (3) reduction of the magnitude and frequency of flows for ecologically important geomorphic processes in the upper and lower Sacramento River below Shasta Dam. With implementation of Mitigation Measure Aqua-4 (CP4/CP4A) (focused on Shasta Lake and vicinity) and Mitigation Measures Aqua-14 (CP4/CP4A) through Aqua-16 (CP4/CP4A) (focused on the Sacramento River downstream from Shasta Lake), adverse effects from CP4 or CP4A would be further reduced, in combination with the downstream geomorphic restoration program elements, and would no longer result in a cumulatively considerable incremental contribution to significant cumulative effects on these resources.

As stated previously, effects of climate change on operations of Shasta Lake could include increased inflows and releases at certain times of the year, and decreased inflows at other times. The additional storage associated with CP4 or CP4A would potentially reduce these effects and allow Shasta Lake to capture some of the increased runoff in the winter and early spring for release in late spring and summer. More importantly, an increased cold-water pool volume will allow Shasta Lake to be managed to provide cooler water releases downstream during critical life stages, particularly for Chinook salmon. Additionally, habitat for both warm- and cold-water reservoir fisheries would be increased with an enlarged reservoir area. Under CP4 or CP4A, potential impacts to Sacramento River fish below Shasta Dam would be beneficial.

Modeling conducted for the Climate Change Modeling Appendix was inconclusive about the effects of this alternative on Delta salinity. If exports are increased under this alternative, it could have an adverse effect on the location of X2, when considered along with other potential projects. However, if the location of X2 remains a water quality and regulatory requirement, then additional exports would not occur when X2 compliance would be violated. Therefore, no cumulative impact on X2 will occur under this alternative.

CP5 – 18.5-Foot Dam Raise, Combination Plan

The cumulative effects of CP5 on special-status mollusks above Shasta Dam, cold-water fish spawning and rearing habitat above Shasta Dam, and ecologically important geomorphic processes below Shasta Dam would be associated with mechanisms similar to those of CP1, CP2, CP3, CP4, and CP4A. However, the magnitude of these impacts would be greater, in many cases, because of the greater inundation area and greater effects increased storage volume on the timing, magnitude, and duration of flows downstream than would occur under CP1 and CP2, but similar to CP3 and CP4/CP4A. Some of these impacts would be partially offset with the implementation of the gravel augmentation program, and floodplain and riparian restoration at six potential sites along the Sacramento River between Keswick Dam and Red Bluff.

Given the scale and duration of the project construction activities associated with CP5, the contribution of CP5 to construction-related cumulative impacts on fisheries and aquatic ecosystems would be cumulatively considerable. CP5 would be undertaken in accordance with a project-specific SWPPP as reviewed and approved by the CVRWQCB. The SWPPP would require implementation of extensive BMPs during project construction, as well as postconstruction site restoration and stabilization to control erosion and sedimentation and to prevent the discharge of pollutants into the Sacramento River and other waterways. Implementation of these measures would reduce the project's contribution to cumulative construction-related impacts to a less-than-significant level.

Given major past alterations to the Sacramento River's aquatic ecosystem and associated aquatic habitats, the contributing adverse effects from CP5 would be cumulatively considerable; specifically, (1) additional inundation of potential riverine habitat for special-status mollusk species above Shasta Dam, (2) additional inundation of cold-water riverine fish spawning and rearing habitat above Shasta Dam, and (3) reduction of the magnitude and frequency of flows for ecologically important geomorphic processes in the upper and lower Sacramento River below Shasta Dam. With implementation of Mitigation Measure Aqua-4 (CP5) (focused on Shasta Lake and vicinity) and Mitigation Measures Aqua-14 (CP5) through Aqua-16 (CP5) (focused on the Sacramento River downstream from Shasta Lake), adverse effects from CP5 would be reduced, in combination with the downstream geomorphic restoration program elements, and would no longer result in a cumulatively considerable incremental contribution to significant cumulative effects on these resources.

As stated previously, effects of climate change on operations of Shasta Lake could include increased inflows and releases at certain times of the year, and decreased inflows at other times. The additional storage associated with CP5 would potentially reduce these effects and allow Shasta Lake to capture some of the increased runoff in the winter and early spring for release in late spring and summer. More importantly, an increased cold-water pool volume will allow Shasta Lake to be managed to provide cooler water releases downstream during critical life stages, particularly for Chinook salmon. Additionally, habitat for both warm- and cold-water reservoir fisheries would be increased with an enlarged reservoir area. Under CP5, potential impacts to Sacramento River fish below Shasta Dam would be beneficial.

Modeling conducted to evaluate project effects on Delta salinity for the Climate Change Modeling Appendix was focused on CP5. Under this alternative Delta outflows are reduced by 15,000 to 100,000 acre-feet/year compared to the Baseline due to greater diversions. The changes are largest with the drier climate scenarios. If exports are increased under this alternative, it could have an adverse effect on the location of X2, when considered along with other potential projects. However, if the location of X2 remains a water quality and regulatory requirement, then additional exports would not occur when X2 compliance would be violated. Therefore, no cumulative impact on X2 will occur under this alternative.

Chapter 12
Botanical Resources and Wetlands

12.1 Affected Environment

This section describes the affected environment related to botanical resources and wetlands for the dam and reservoir modifications that are proposed under SLWRI action alternatives. For a more in-depth description, see the *Botanical Resources and Wetlands Technical Report*.

The botanical resources and wetlands setting for the Shasta Lake and vicinity portion of the primary study area consists of the impoundment area (five arms and the Main Body of Shasta Lake, as described below) and the relocation areas (Figure 12-1).

Reclamation established project boundaries for focused surveys in the areas that would be subject to inundation under the various enlargement scenarios. The lower boundary corresponds to the current full pool elevation defined by Reclamation (1,070-foot mean sea level contour line). The upper boundary was established using the 1,090-foot mean sea level contour line around the entire lake. This area is referred to as the “impoundment area” (Figure 12-1).

Areas subject to physical disturbance as an indirect result of the proposed project (i.e., areas proposed as relocation sites for roadways, bridges, utilities, and campgrounds that would be inundated after the enlargement of Shasta Dam as well as proposed dike locations) were incorporated into the Shasta Lake and vicinity portion of the primary study area. These locations are hereafter referred to as “relocation areas” (Figure 12-1).

To examine the biological resources along riverine reaches that would be subject to inundation if Shasta Dam were enlarged, reaches of 11 streams and rivers that are tributary to Shasta Lake were also incorporated into the Shasta Lake and vicinity portion of the primary study area. These streams were selected by Reclamation in conjunction with the USFS as an initial sampling of streams representative of riverine and riparian habitats. Subsequently, botany studies have been expanded into select areas of the impoundment area and within all of the relocation areas.

As a component of the SLWRI, Reclamation proposes to restore and/or enhance riparian and riverine habitats at six locations along the lower Sacramento River below Shasta Dam. These six locations occur generally between the city of Redding and Reading Island, Shasta County, California. The purpose of the restoration effort is to improve spawning and rearing habitat for anadromous fish occurring in the Sacramento River. These six locations are referred to as the potential Sacramento River downstream habitat restoration areas (Figure 12-2).

For the purposes of this investigation, approximate acreages for vegetation types and waters of the United States are reported by arm of the lake. For a relocation area that falls between two arms, the area is included with the arm that has the most acreage of the vegetation type or water of the United States. Habitats and waters of the United States are also reported for the potential Sacramento River downstream habitat restoration areas.

Vegetation communities and special-status plant species in the extended study area are discussed in less detail. The extended study area includes the Sacramento River basin from Red Bluff Pumping Plant (RBPP) south to the Delta. It also includes the San Francisco Bay/Sacramento-San Joaquin Delta (Bay-Delta) area and portions of the American River basin, San Joaquin River basin, and the water service areas of the CVP and the SWP.

Descriptions of biological resources were derived primarily from the following sources:

- SLWRI Mission Statement Milestone Report (Reclamation 2003)
- SLWRI Initial Alternatives Information Report (Reclamation 2004)
- Chapter 3, "Biological Environment," in the Draft SLWRI Plan Formulation Report (Reclamation 2007)
- USFWS Endangered Species Lists
- The California Natural Diversity Database (CNDDB)
- The California Native Plant Society (CNPS) online inventory
- Numerous technical studies of botanical and wetland resources conducted by Reclamation in the Shasta Lake and vicinity portion of the primary study area since 2002.

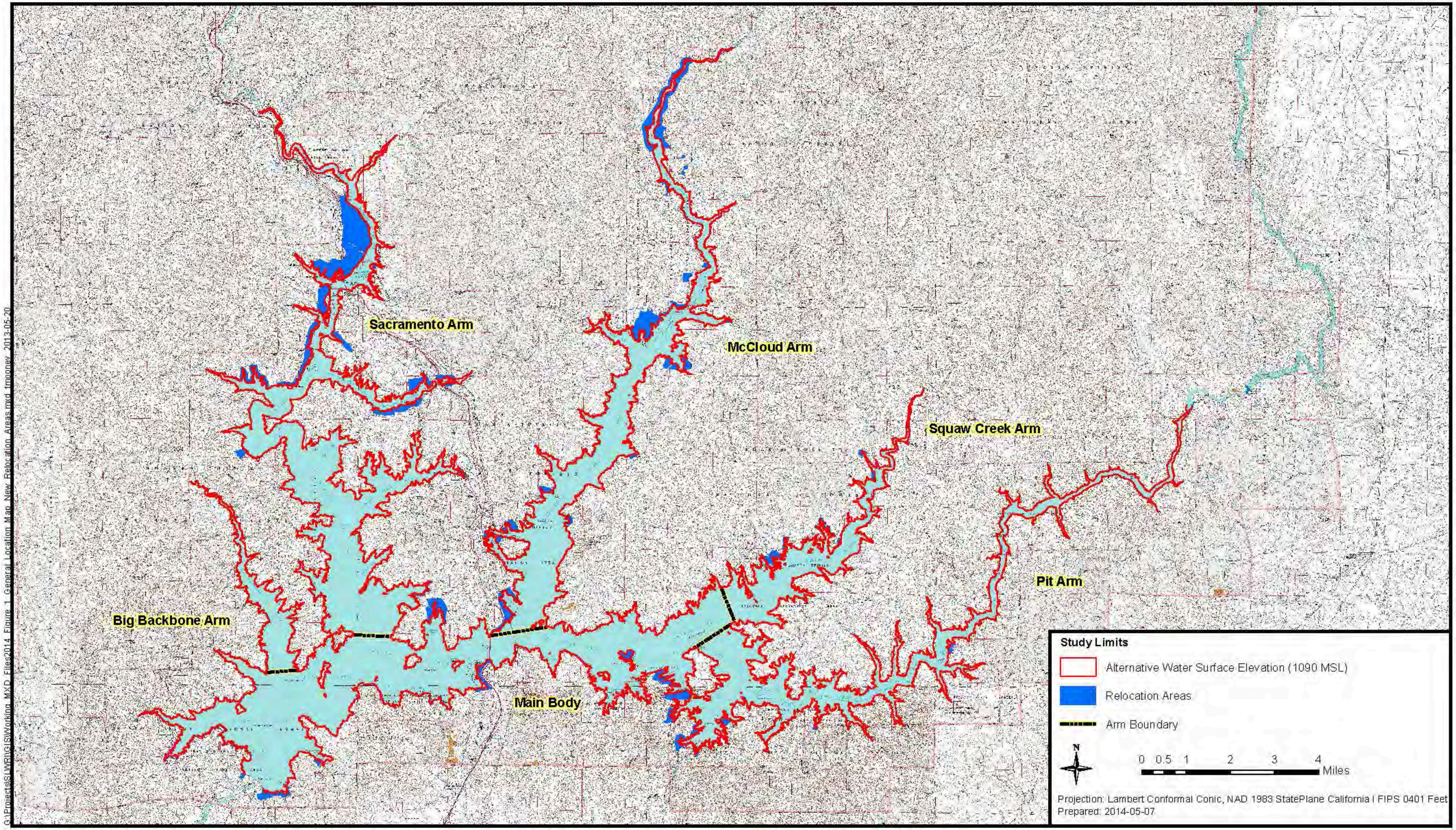


Figure 12-1. Study Limits

This page left blank intentionally.

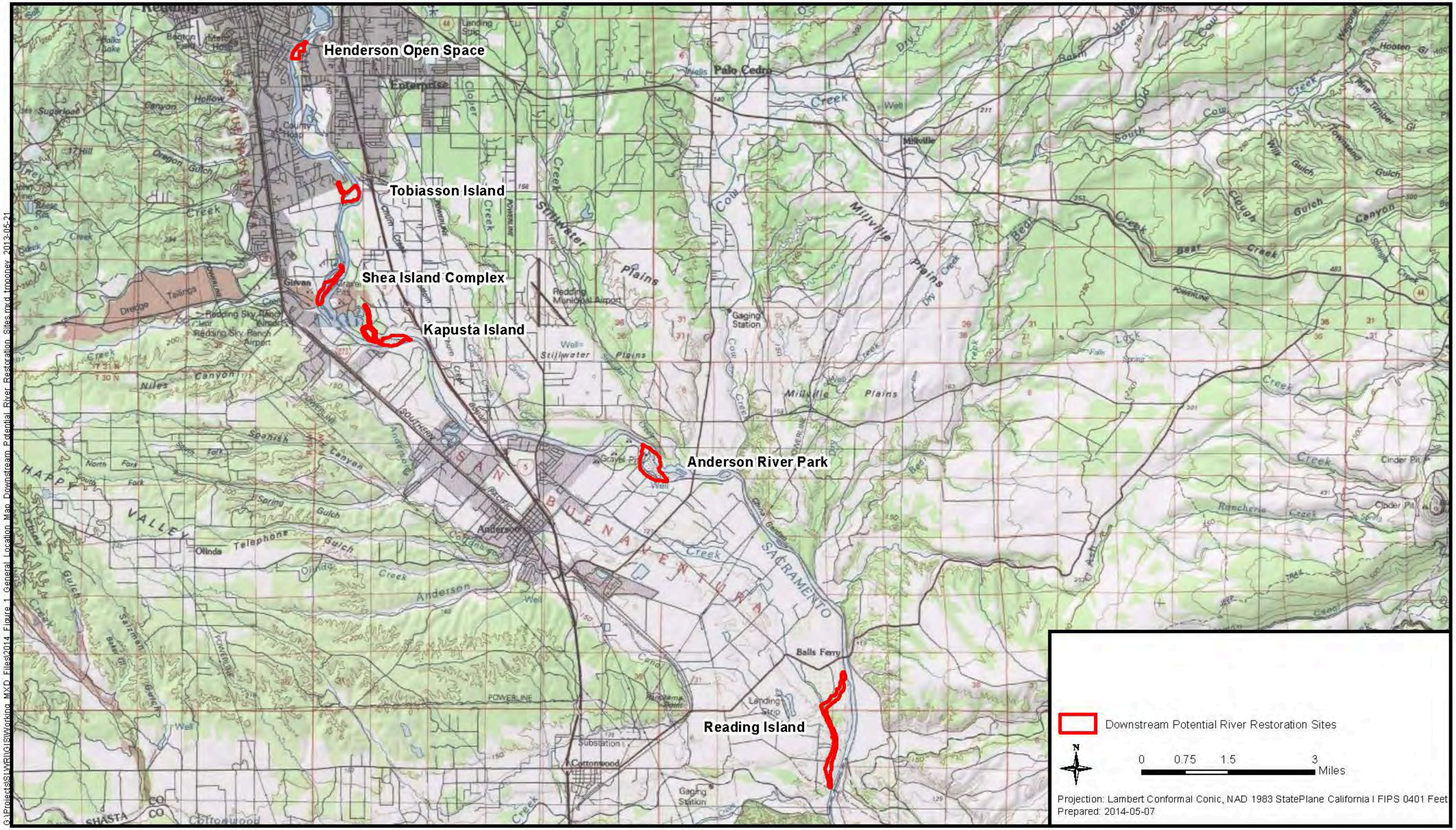


Figure 12-2. General Location Map Downstream Potential River Restoration Areas

This page left blank intentionally.

Several attachments to the *Botanical Resources and Wetlands Technical Report* provide detailed lists and descriptions of special-status species present in the primary and extended study areas:

- Attachment 1, "Lists of All Special-Status Plant Species Known from or Potentially Present in the Primary and Extended Study Areas"
- Attachment 2, "List of Plant Species Observed in the Shasta Lake and Vicinity Portion of the Primary Study Area"
- Attachment 3, "Special-Status Plant Species Known to Occur in the Shasta Lake and Vicinity Portion of the Primary Study Area"
- Attachment 4, "List of All Sensitive Plant Species in the Extended Study Area Reported to the CNDDB"
- Attachment 5, "Known Weed Source Locations, Potential Mode of Spread, and Risk of Spread"
- Attachment 6, "Botanical Survey Report 2002-2014"

12.1.1 Vegetation Communities

Shasta Lake and Vicinity

Reclamation conducted extensive mapping to characterize the plant communities in the Shasta Lake and vicinity portion of the primary study area. The study area for botanical resources and wetlands in the Shasta Lake and vicinity portion of the primary study area corresponds to the area that would be subject to inundation under all action alternatives and areas where infrastructure would be removed, modified, or relocated (Figure 12-1). The vegetation mapping followed the technical approach described in *A Manual of California Vegetation* (MCV) (Sawyer and Keeler-Wolf 1995), using the vegetation alliance classification system described in *A Manual of California Vegetation, Second Edition* (Sawyer et al, 2009).

The MCV represents the most recent effort to provide a common and accepted vegetation classification system for use throughout California. It classifies vegetation into a set of plant alliances, provisional alliances, special stands, or semi-natural stands. In this system, the plant species dominance or importance in the layer (i.e., tree, shrub, and ground) with the greatest amount of cover determines the vegetation alliance classification. The same approach used to describe and classify MCV types was applied when other vegetation types not described in the current MCV were encountered and determined to be significant vegetative components.

Vegetation mapping was conducted using recent 1:2,400-scale rectified color aerial photography. All vegetation mapping was performed in the field by ground truthing the primary study area from boat, vehicle, and/or on foot. MCV plant alliances were identified and delineated onto the aerial photographs. The delineated boundaries were digitized and generated in ArcGIS/ArcInfo software for display and data query purposes.

The Shasta Lake and vicinity area is characterized by a variety of vegetation types typical of transitional mixed woodland and low-elevation forest habitats. MCV plant series types in this portion of the primary study area are birch-leaf mountain mahogany chaparral, black willow thicket, blue oak woodland, Brewer's oak scrub, buck brush chaparral, California annual grassland, California black oak forest, California ash chaparral, California buckeye groves, California yerba santa scrub, canyon live oak forest, deer brush chaparral, Fremont cottonwood forest, ghost pine woodland, Himalayan blackberry brambles, interior live oak chaparral, interior live oak woodland, knobcone pine forest, mixed willow, Oregon ash groves, Oregon white oak woodland, pale spike rush marshes, ponderosa pine–Douglas fir forest, ponderosa pine forest, red osier thickets, sandbar willow thickets, spicebush thickets, valley oak woodland, white alder groves, and white leaf manzanita chaparral. Vegetation in each of these series varies, with dramatic changes often occurring in relation to aspect, slope, geologic substrate, or juxtaposition with other habitats.

Summaries of MCV types found in the impoundment area along the Main Body and the five arms of Shasta Lake are shown in Table 12-1, and the acreage of MCV types found in the relocation areas along the Main Body and the five arms of Shasta Lake is shown in Table 12-2. The locations of each type are depicted on Figures 12-3a through 12-3f. General descriptions of each type are provided below. Plant taxonomy follows Baldwin et al. (2012).

Table 12-1. Summary of Plant Communities in the Impoundment Area

Plant Series	Area (Acres)						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Arroyo willow thickets	0.15	0.00	0.00	0.00	0.00	0.00	0.15
Barren[1]	2.30	0.00	13.16	11.18	0.00	2.84	29.48
Birch-leaf mountain-mahogany chaparral	0.00	0.00	0.00	2.23	0.00	0.00	2.23
Black willow thicket	0.00	0.00	0.02	0.00	0.00	0.02	0.04
Blue oak woodland	1.27	0.00	0.00	0.70	0.00	4.08	6.05
Brewer oak scrub	9.78	0.17	51.62	4.99	4.51	7.78	78.85
Buck brush chaparral	0.90	2.42	2.11	1.59	0.67	0.19	7.88
California annual grassland	0.58	0.34	4.17	0.94	0.00	0.33	6.36
California black oak forest	71.45	14.14	160.32	47.44	1.72	5.06	300.13
California buckeye groves	0.00	0.00	0.20	0.001	0.00	0.00	0.20
California yerba santa scrub	0.75	0.00	0.00	0.00	0.00	11.58	12.33
Canyon live oak forest	9.80	18.41	53.80	48.31	26.78	110.51	267.61
Deer brush chaparral	0.18	0.00	0.00	0.08	0.00	2.34	2.60
Fremont cottonwood forest	0.00	0.00	0.07	0.00	0.00	0.05	0.12
Ghost pine woodland	54.05	0.00	51.29	13.50	22.03	30.54	171.41
Himalayan blackberry brambles	0.00	0.00	0.00	0.00	0.00	0.44	0.44
Interior live oak chaparral	1.24	0.00	10.05	0.01	0.00	24.22	35.52
Interior live oak woodland	2.00	0.00	0.14	0.09	0.00	2.28	4.51
Knobcone pine forest	32.96	0.40	16.38	20.72	47.87	79.83	198.16
Mixed willow	1.39	1.46	14.56	0.16	0.19	0.83	18.59
Oregon ash groves	0.00	0.00	0.00	0.17	0.00	0.00	0.17
Oregon white oak woodland	0.00	0.00	0.00	1.09	0.00	0.66	1.75
Ponderosa pine–Douglas fir forest	5.02	0.00	28.37	50.04	69.02	127.51	279.96
Ponderosa pine forest	225.95	36.67	212.79	208.77	59.33	101.17	808.01

Table 12-1. Summary of Plant Communities in the Impoundment Area (contd.)

Plant Series	Area (Acres)						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Red osier thickets	0.00	0.00	0.00	0.12	0.00	0.00	0.12
Riverine[1]	0.00	0.88	5.24	15.43	1.41	0.00	22.96
Sandbar willow thickets	0.00	0.00	0.00	0.28	0.07	0.00	0.35
Spicebush thickets	0.00	0.00	0.00	0.06	0.00	0.00	0.06
Urban[1]	22.04	0.00	0.00	0.00	0.00	1.92	23.96
White alder groves	1.34	4.47	9.70	12.40	1.18	2.85	31.94
White leaf manzanita chaparral	16.60	12.30	98.22	6.21	7.49	2.86	143.68
Total	459.76	91.67	732.20	446.49	242.28	519.90	2492.29

Notes
[1] CWHR Wildlife Habitat Type; no corresponding plant series type included in *A Manual of California Vegetation* (Sawyer and Keeler-Wolf 1995).

Table 12-2. Summary of Plant Communities in the Relocation Areas

Plant Series	Area (Acres)						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Barren[1]	22.32	0.00	74.17	29.66	11.53	12.77	150.46
Birch-leaf mountain-mahogany chaparral	0.00	0.00	0.00	0.41	0.00	0.00	0.41
Black willow thicket	0.00	0.00	0.03	0.00	0.00	0.00	0.03
Blue oak woodland	0.00	0.00	0.00	3.68	0.00	0.93	4.61
Brewer oak scrub	5.46	0.00	13.22	8.40	0.00	0.12	27.20
Buck brush chaparral	0.00	0.00	0.77	1.45	0.00	0.04	2.26
California annual grassland	4.76	0.00	20.31	9.75	0.84	0.23	35.89
California ash chaparral	0.00	0.00	0.00	0.68	0.00	0.00	0.68
California black oak forest	35.03	0.00	131.78	77.04	1.29	0.04	245.17
California buckeye groves	0.00	0.00	0.00	1.58	0.00	0.00	1.58
California yerba santa scrub	0.09	0.00	0.00	0.00	0.00	2.75	2.83
Canyon live oak forest	1.06	0.00	8.10	77.26	4.98	5.60	96.99

Table 12-2. Summary of Plant Communities in the Relocation Areas (contd.)

Plant Series	Area (Acres*)						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Deer brush chaparral	0.18	0.00	0.00	0.57	0.00	0.40	1.15
Ghost pine woodland	105.48	0.00	41.27	29.95	13.48	11.94	202.11
Himalayan blackberry brambles	0.15	0.00	0.00	0.06	0.00	0.00	0.21
Interior live oak chaparral	0.00	0.00	0.60	0.00	0.00	22.70	23.29
Interior live oak woodland	0.00	0.00	0.00	0.00	0.00	0.05	0.05
Knobcone pine forest	0.11	0.00	40.64	9.65	1.94	13.96	66.30
Lacustrine[1]	0.00	0.00	0.00	0.001	0.00	0.00	0.001
Mixed willow	0.08	0.00	0.73	0.00	0.06	0.01	0.87
Oregon ash groves	0.00	0.00	0.00	0.33	0.00	0.00	0.33
Oregon white oak woodland	0.00	0.00	0.00	5.72	0.07	0.00	5.72
Pale spike rush marshes	0.00	0.00	6.51	0.00	0.00	0.00	6.51
Ponderosa pine–Douglas fir forest	0.00	0.00	13.06	106.07	15.62	11.80	146.55
Ponderosa pine forest	156.56	0.00	458.50	347.64	43.08	35.97	1041.75
Riverine[1]	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sandbar willow thickets	0.00	0.00	0.00	0.09	0.00	0.00	0.09
Spicebush thickets	0.00	0.00	0.00	0.64	0.00	0.00	0.64
Urban[1]	20.65	0.00	227.46	0.48	0.00	0.57	249.16
Valley oak woodland	0.00	0.00	1.06	0.00	0.00	0.00	1.06
White alder groves	0.00	0.00	0.23	1.90	0.17	0.00	2.31
White leaf manzanita chaparral	7.28	0.00	41.41	14.88	4.38	0.00	67.94
Total	359.20	0.00	1,079.84	727.92	97.44	119.83	2,387.23

Note:
[1] CWHR Wildlife Habitat Type; no corresponding plant series type included in *A Manual of California Vegetation* (Sawyer and Keeler-Wolf 1995).

This page intentionally left blank.

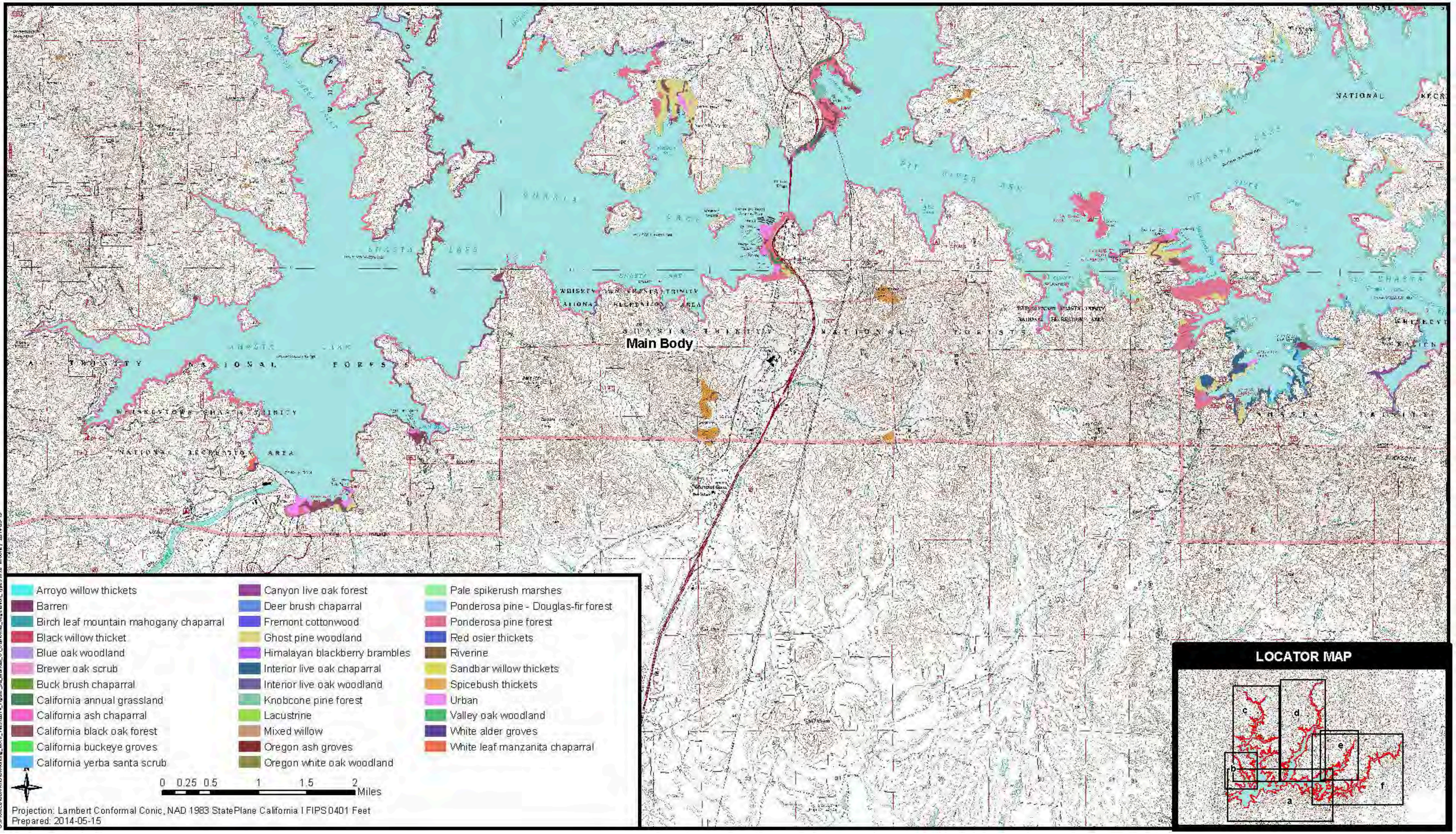


Figure 12-3a. Manual of California Vegetation Types

This page left blank intentionally.

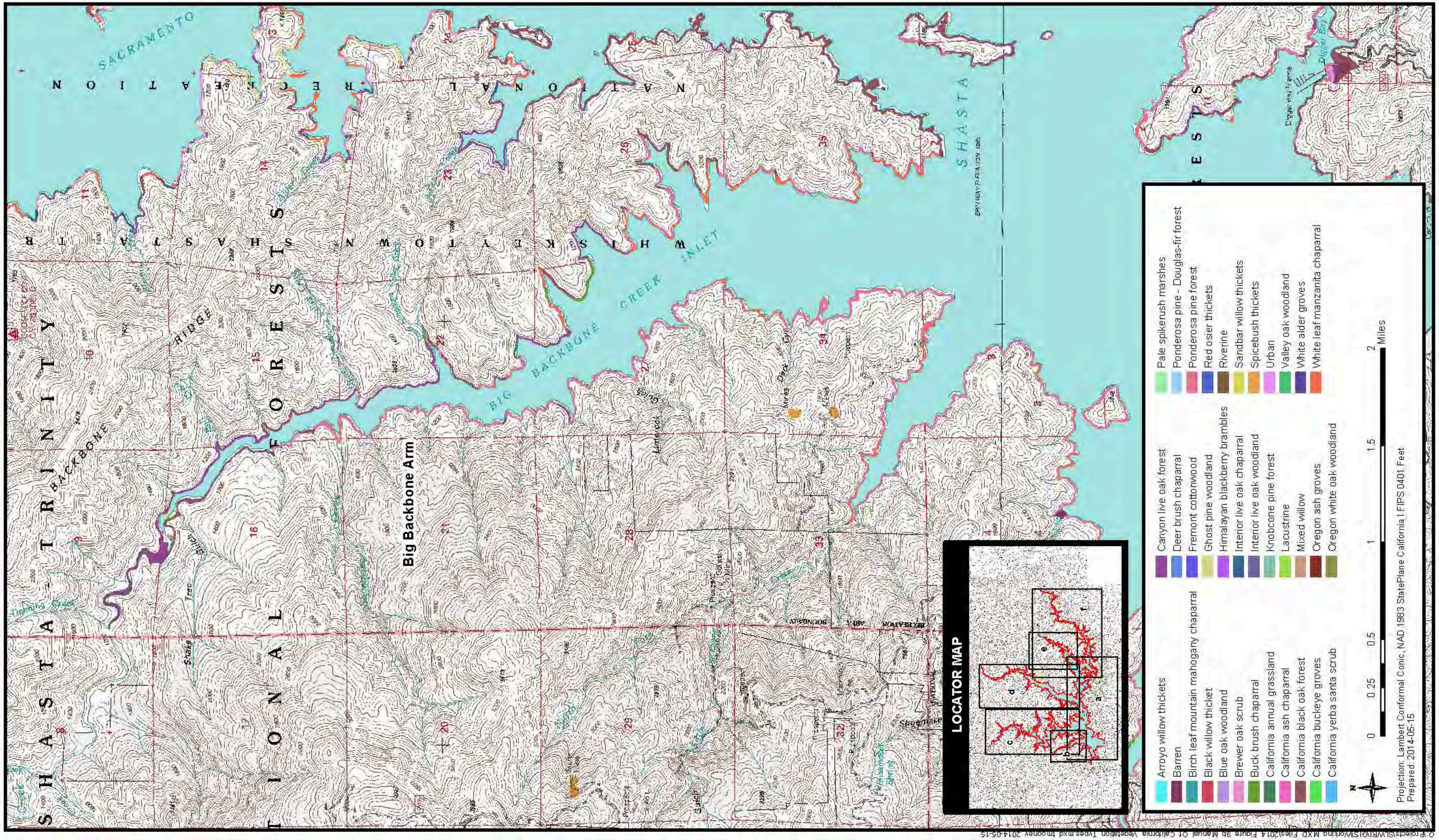


Figure 12-3b. Manual of California Vegetation Types

This page left blank intentionally.

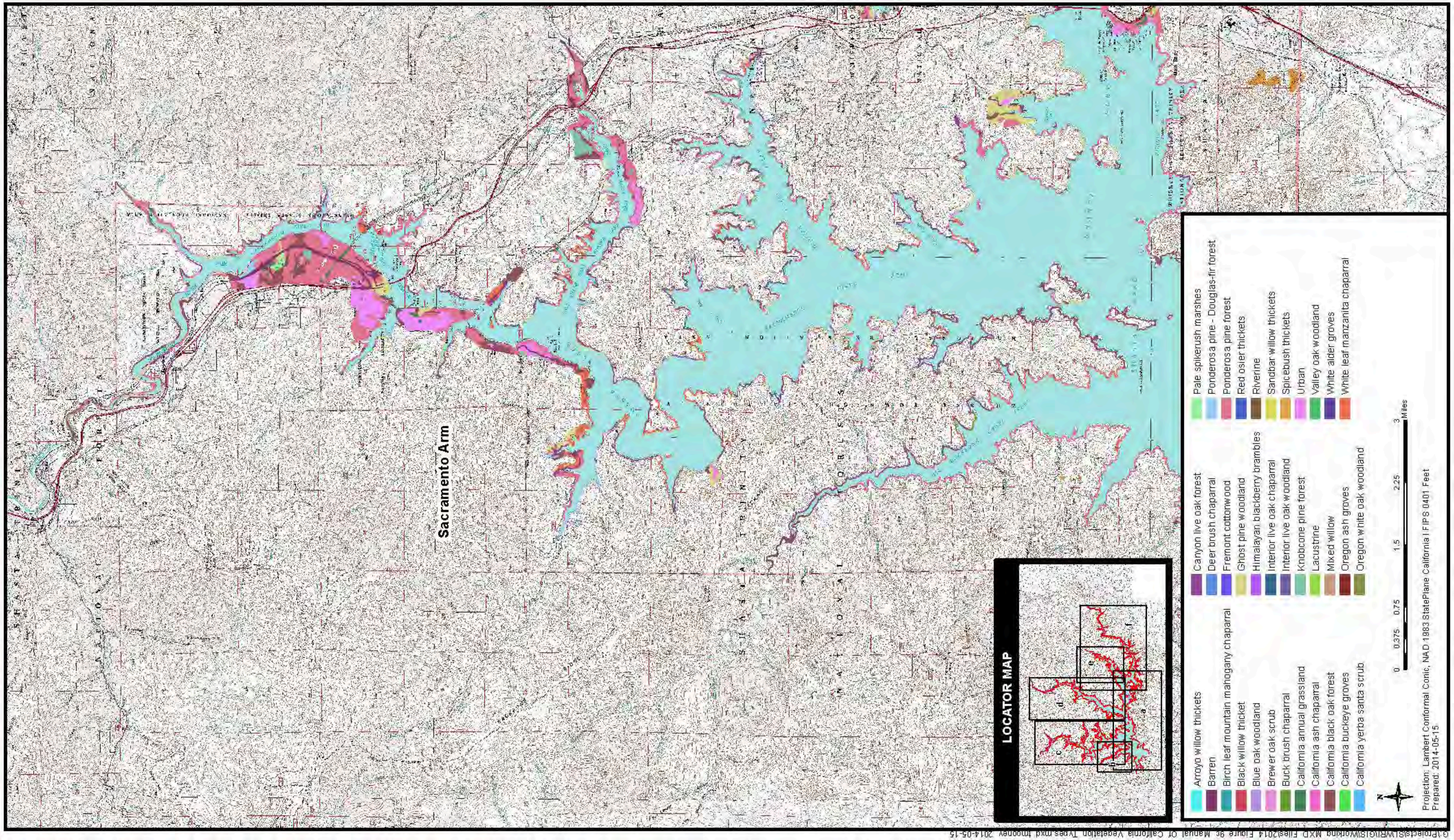


Figure 12-3c. Manual of California Vegetation Types

This page left blank intentionally.

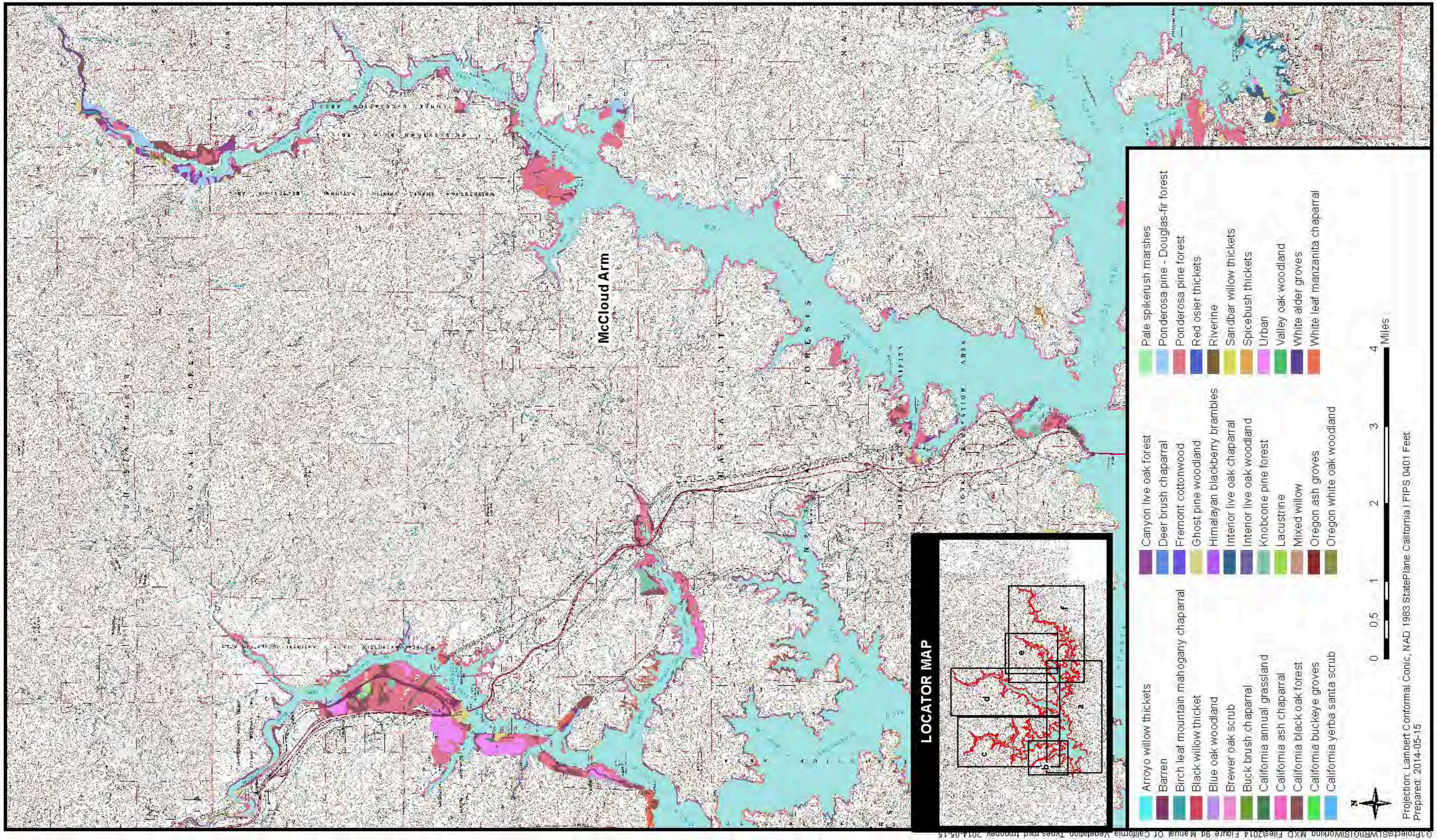


Figure 12-3d. Manual of California Vegetation Types

This page left blank intentionally.

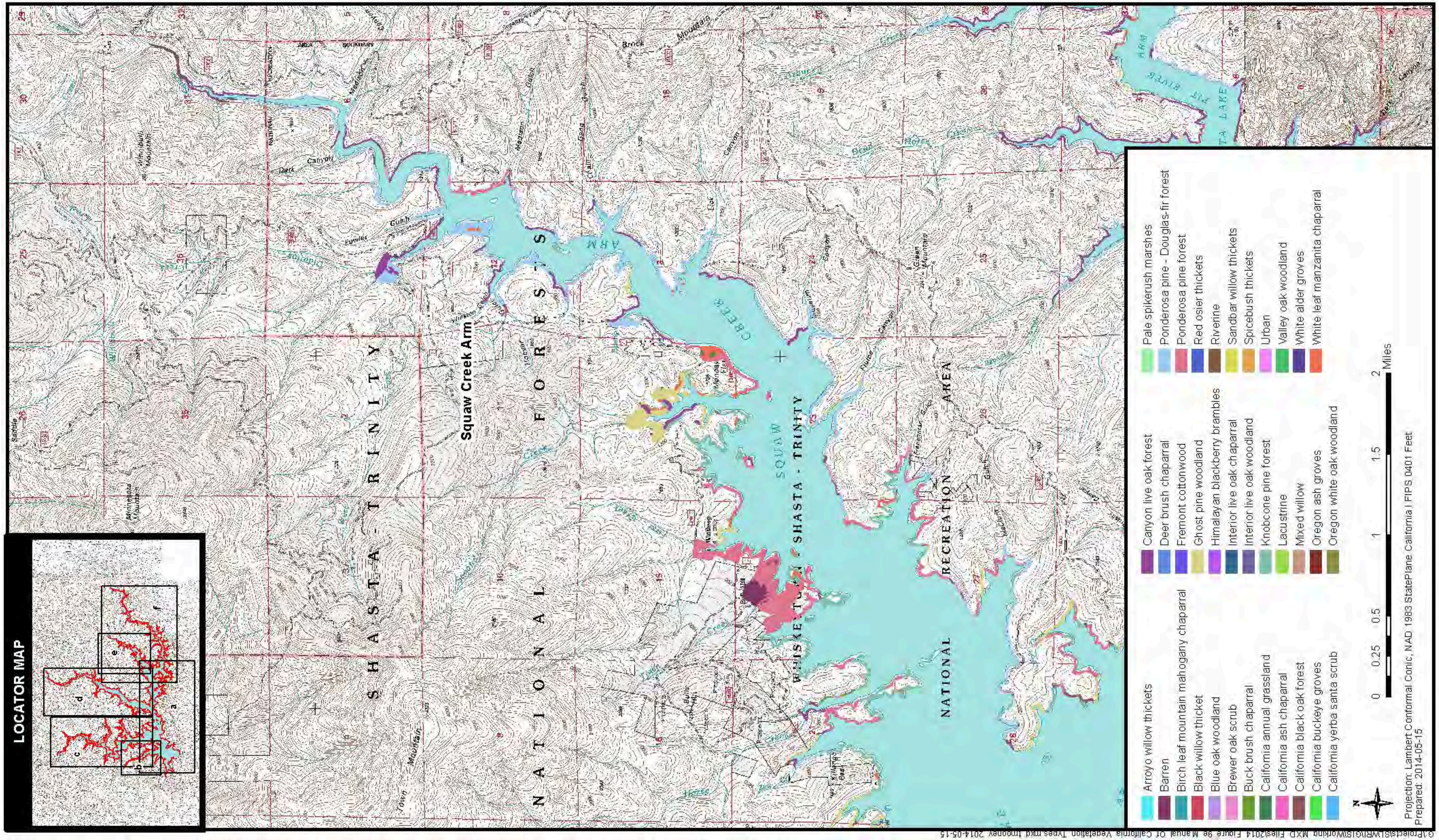


Figure 12-3e. Manual of California Vegetation Types

This page left blank intentionally.

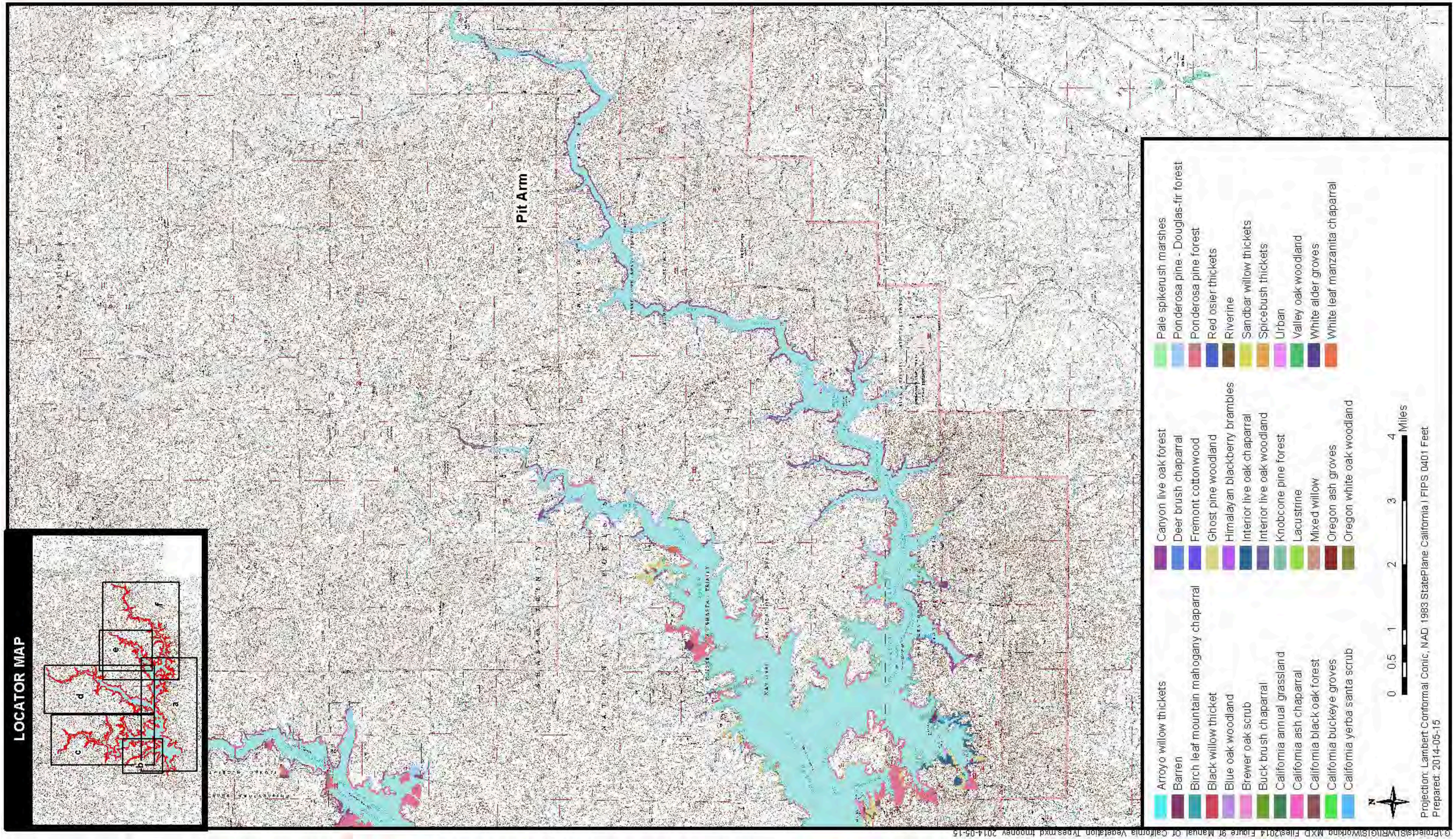


Figure 12-3f. Manual of California Vegetation Types

This page left blank intentionally.

Barren Barren habitat consists mainly of nonvegetated human-made features. Barren habitat is scattered throughout the Shasta Lake and vicinity portion of the primary study area, including boat ramps, parking lots, and roads. Other barren habitats are a large gravel plain feature at the confluence of Butcher Creek and Shasta Lake (Main Body) and a sealed riprap feature adjacent to Interstate 5 near the upper Sacramento Arm and Shasta Lake confluence. Vegetation is usually not present, although sparse opportunistic grasses/forbs or weedy species may occur.

Birch-Leaf Mountain-Mahogany Chaparral Birch-leaf mountain-mahogany chaparral is a relatively common associate species in many chaparral and woodland plant series types. As a plant series, birch-leaf mountain-mahogany occurs in the Shasta Lake and vicinity portion of the primary study area along the upper McCloud and Sacramento arms. These sites are located on floodplain terraces and are characterized as moderate to dense chaparral stands dominated by birch-leaf mountain-mahogany (*Cercocarpus betuloides*), with occasional buck brush (*Ceanothus cuneatus*), poison oak (*Toxicodendron diversilobum*), western redbud (*Cercis occidentalis*), yerba santa (*Eriodictyon californicum*), and Brewer oak (*Q. garryana* var. b*reweri*).

Black Willow Thicket Although commonly associated with willow and other riparian plant series types, black willow thicket is uncommon in the Shasta Lake and vicinity portion of the primary study area. This plant series is dominated by black willow (*Salix gooddingii*), with spicebush (*Calycanthus occidentalis*), rushes (*Juncus* spp.), and California grape (*Vitis californica*). It occurs at only two locations in the Shasta Lake and vicinity portion of the primary study area, one along the Sacramento Arm and the other in the Jones Valley area (Pit Arm).

Blue Oak Woodland The blue oak plant series occurs mainly as small inclusions within other more prevalent plant series types; however, moderate-sized stands also occur. This plant series occurs at scattered locations along the Main Body, McCloud Arm, and Pit Arm and is characterized by open to moderate woodlands dominated by blue oak (*Quercus douglasii*). Associated tree species include occasional interior live oak (*Q. wislizenii* var. *wislizenii*) and gray pine (*Pinus sabiniana*). The shrub layer is open or absent, and a moderate to dense forb layer dominates the understory.

Brewer Oak Scrub The Brewer oak plant series consists of moderate to very dense stands of Brewer oak, the shrub form of Oregon white oak (*Q. garryana* var. *garryana*). This plant series type is widespread throughout the Shasta Lake and vicinity portion of the primary study area. Brewer oak stands are often nearly pure; occasionally, however, shrub species such as poison oak, white leaf manzanita, yerba santa, buck brush, bush poppy (*Dendromecon rigida*), Fremont's silktassel (*Garrya fremontii*), deer brush (*Ceanothus integerrimus*), skunkbrush (*Rhus trilobata*), and snowdrop bush (*Styrax officinalis*) occur in association with Brewer oak.

Buck Brush Chaparral Buck brush chaparral occurs at scattered locations throughout the Shasta Lake and vicinity portion of the primary study area. This plant series is dominated by moderate to dense stands of buck brush. Associated species include white leaf manzanita, poison oak, western redbud, yerba santa, Brewer oak, birch-leaf mountain-mahogany, and coffeeberry (*Frangula* sp.).

California Annual Grassland California annual grassland is uncommon in the Shasta Lake and vicinity portion of the primary study area, occurring only as small inclusions in other more prevalent plant series types or in areas subjected to previous disturbance. Dominant species include wild oat (*Avena fatua*), downy brome (*Bromus tectorum*), ripgut (*B. diandrus*), yellow star-thistle (*Centaurea solstitialis*), squirreltail (*Elymus elymoides*), and European hairgrass (*Aira caryophyllea*).

California Ash Chaparral California ash (*Fraxinus dipetala*) is a relatively common associate species in many chaparral and woodland plant series types. As a plant series, California ash chaparral occurs in the Shasta Lake and vicinity portion of the primary study area at several locations along the McCloud Arm. This plant series is characterized as a moderate to dense chaparral stand dominated by California ash, with occasional birch-leaf mountain-mahogany, buck brush, poison oak, western redbud, yerba santa, and Brewer oak.

California Black Oak The black oak series is characterized by moderate to dense stands of California black oak (*Quercus kelloggii*). This plant series is relatively common throughout the Shasta Lake and vicinity portion of the primary study area. Understory associates include white leaf manzanita (*Arctostaphylos viscida*), poison oak, snowdrop bush (*Styrax officinalis*), and buck brush. The ground layer is open to dense and is dominated by various grasses and forbs.

California Buckeye Groves Although a common associate in many plant series types in the Shasta Lake and vicinity portion of the primary study area, California buckeye groves are uncommon as a plant series type. This plant series is dominated by California buckeye (*Aesculus californica*). Associated species include poison oak, Brewer oak, buck brush, and various grasses and forbs. It occurs at only several scattered locations in the Sacramento Arm, McCloud Arm, and Pit Arm.

California Yerba Santa Scrub California yerba santa scrub is a relatively common associate species in many chaparral and woodland plant series types. California yerba santa is a pioneer species that readily responds to various disturbances and wildfire. As a plant series, California yerba santa scrub occurs in the Shasta Lake and vicinity portion of the primary study area at two general locations subject to wildfires in 2004 and 2008: the Dry Creek area (Main Body) and the Jones Valley area (Pit Arm). This plant series is characterized as moderate to dense chaparral stands dominated by California yerba santa, with occasional shrub interior live oak, shrub canyon live oak, buck brush, poison oak, western redbud, and Brewer oak.

Canyon Live Oak Forest The canyon live oak plant series is characterized by moderate to dense stands of canyon live oak (*Quercus chrysolepis*). This plant series is relatively common throughout the Shasta Lake and vicinity portion of the primary study area. Associated tree species include occasional California black oak. Understory associates include white leaf manzanita and poison oak. The ground layer is open to moderate and is dominated by various grasses and forbs.

Deer Brush Chaparral Deer brush chaparral is a relatively common associate in chaparral and forest plant series types in the Shasta Lake and vicinity portion of the primary study area; however, deer brush is uncommon in the study area as a plant series type. This plant series is dominated by deer brush. It occurs at several scattered locations along the Main Body, McCloud Arm, and Pit Arm.

Fremont Cottonwood Forest In the Shasta Lake and vicinity portion of the primary study area, Fremont cottonwood forest is an uncommon plant series type that occurs as single stands of trees along small portions of the upper Sacramento Arm and the Pit Arm. The dominant species is Fremont cottonwood (*Populus fremontii*).

Ghost (Gray) Pine The ghost pine plant series occurs in all parts of the Shasta Lake and vicinity portion of the primary study area except along the Big Backbone Arm. This plant series type is characterized by open to moderate stands of gray pine. Associated species include blue oak, canyon live oak, interior live oak, and California black oak. Shrub species are moderate to dense and include white leaf manzanita, western redbud, buck brush, Brewer oak, poison oak, and yerba santa.

Himalayan Blackberry Brambles Himalayan blackberry (*Rubus armeniacus*) is a common associate in many riparian plant series and in various other plant series with mesic microhabitats and/or previous disturbance. As a plant series, Himalayan blackberry brambles occur in portions of the Dry Creek (Main Body) and Jones Valley (Pit Arm) areas recently disturbed by wildfire. This plant series occurs in and along drainage and stream features and is characterized as dense thickets of Himalayan blackberry. Associated species include spicebush, willow, and rushes.

Interior Live Oak Chaparral In the Shasta Lake and vicinity portion of the primary study area, the interior live oak chaparral plant series is relatively uncommon, occurring mainly along the Sacramento Arm. However, this plant series also occurs at scattered locations along the Main Body, the McCloud Arm, and the Pit Arm. This plant series is dominated by moderate to dense stands of the shrub form of interior live oak. Associated species include Brewer oak, white leaf manzanita, poison oak, and buck brush.

Interior Live Oak Woodland The interior live oak woodland plant series is uncommon in the Shasta Lake and vicinity portion of the primary study area. It occurs in several small areas along the Sacramento Arm, the Pit Arm, the McCloud Arm, and the Main Body.

Knobcone Pine Forest The knobcone pine forest plant series consists of open to dense knobcone pine (*Pinus attenuata*) stands. This plant series is scattered throughout all portions of the Shasta Lake and vicinity portion of the primary study area. Knobcone pine forest often occurs at locations characterized by disturbances, including historic mining activities and past or recent wildfires. Dominant species include knobcone pine, with occasional canyon live oak, California black oak, ponderosa pine (*Pinus ponderosa*), and gray pine. The shrub layer is moderate to dense and is dominated by white leaf manzanita and poison oak. The ground layer varies and is dominated by various grasses and forbs.

Lacustrine Lacustrine habitat consists of the area regularly inundated by Shasta Lake (i.e., areas at and below the 1,070-foot elevation). Most of this area is barren of vegetation and is characterized as exposed soil and/or rock. Portions of the lacustrine habitat do support vegetation, including woody riparian species such as black willow, button willow (*Cephalanthus occidentalis*), Fremont cottonwood, and various grasses and forbs, during draw-down periods.

Mixed Willow Mixed willow is the most common willow plant series type in the Shasta Lake and vicinity portion of the primary study area and occurs throughout the entire area. Dominant species include red willow (*Salix laevigata*), black willow, shining willow (*S. lasiandra*), arroyo willow (*S. lasiolepis*), and narrowleaf willow (*S. exigua*).

Oregon Ash Groves Oregon ash groves are an uncommon plant series type in the Shasta Lake and vicinity portion of the primary study area. This type occurs along the upper McCloud Arm and is dominated by open to moderate stands of Oregon ash (*Fraxinus latifolia*) with willow, California grape, mock orange, brickellbush (*Brickellia* sp.), and poison oak.

Oregon White Oak Woodland The Oregon white oak woodland plant series is uncommon in the Shasta Lake and vicinity portion of the primary study area and occurs as small inclusions in other more prevalent plant series types. This plant series is characterized by open to moderate woodlands dominated by Oregon white oak. Associated tree species include occasional canyon live oak, blue oak, and California black oak. The shrub layer is open or absent, and a moderate to dense forb layer dominates the understory.

Pale Spike Rush Marshes Pale spike rush is an uncommon plant series in the Shasta Lake and vicinity portion of the primary study area; it is known to occur only in a portion of one relocation area near Lakehead (Sacramento Arm). This plant series is characterized as a seasonal wetland dominated by a complex of annual and perennial upland and wetland plant species. Dominant species include pale spike rush (*Eleocharis macrostachya*), jointed coyote-thistle (*Eryngium articulatum*), pennyroyal (*Mentha pulegium*), panic grass (*Panicum acuminatum*), iris-leaf rush (*Juncus xiphioides*), sedges (*Carex* spp.), rushes, poison oak, white leaf manzanita, western choke-cherry (*Prunus virginiana*), interior rose (*Rosa woodsii*), and Himalayan blackberry.

Ponderosa Pine–Douglas-Fir Ponderosa pine-Douglas-fir is the second-most-common conifer plant series type in the Shasta Lake and vicinity portion of the primary study area, occurring everywhere except along the Big Backbone Arm. This plant series is characterized by open to dense conifer stands dominated by Douglas-fir (*Pseudotsuga menziesii*) and ponderosa pine. Associated species include occasional sugar pine (*P. lambertiana*), incense cedar (*Calocedrus decurrens*), canyon live oak, and California black oak. Associated understory species vary and include Pacific dogwood (*Cornus nuttallii*), mock orange (*Philadelphus lewisii*), poison oak, snowdrop bush, and white leaf manzanita. The ground layer is open to moderate and is dominated by various grasses and forbs.

Ponderosa Pine Ponderosa pine is the most common conifer plant series type in the Shasta Lake and vicinity portion of the primary study area and is scattered throughout all portions of the area. This plant series is characterized by open to dense conifer stands dominated by ponderosa pine. Associated species include occasional Douglas-fir, sugar pine, incense cedar, canyon live oak, and California black oak. Associated understory species vary and include redbud, buck brush, mock orange, poison oak, snowdrop bush, and white leaf manzanita. The ground layer is open to moderate and is dominated by various grasses and forbs.

Red Osier Thickets Red osier is a common associate in many riparian plant series types in the Shasta Lake and vicinity portion of the primary study area. As a plant series, red osier thickets are an uncommon plant series type. In the vicinity of Shasta Lake, red osier thickets are found along the upper McCloud Arm. Dominant species include red osier (*Cornus stolonifera*), brown dogwood (*C. glabrata*), mock orange, spicebush, and California grape.

Riverine Riverine habitat includes the free-flowing portions of the larger Shasta Lake tributaries occurring in the Shasta Lake and vicinity portion of the primary study area. The riverine habitat is highly variable and ranges from moderate, low-gradient to steep, well-confined stream reaches.

Sandbar Willow Thickets Sandbar willow thicket is an uncommon plant series that occurs at one location each along the McCloud Arm and the Squaw Creek Arm. Dominant species include narrowleaf willow, with occasional red willow, black willow, shining willow, and arroyo willow.

Spicebush Thickets Spicebush is a common associate in many riparian plant series types in the Shasta Lake and vicinity portion of the primary study area. As a plant series, spicebush thickets are an uncommon plant series type. This plant series occurs at several locations along the McCloud Arm. Dominant species include spicebush, red osier, mock orange, and California grape.

Urban Urban habitat consists of various man-made features scattered throughout the Shasta Lake and vicinity portion of the primary study area, including resorts and a portion of the visitor center complex at Shasta Dam. These features are typically a combination of various buildings, pavement areas with manicured landscaping, and lawns.

Valley Oak Woodland Valley oak woodland is an uncommon plant series and occurs at two small locations in the Lakehead area (Sacramento Arm). Dominant species include valley oak (*Quercus lobata*) with white leaf manzanita, redbud, poison oak, and various grasses and forbs.

White Alder Groves The white alder plant series occurs in the riparian vegetation found in drainages throughout the Shasta Lake and vicinity portion of the primary study area. This plant series is characterized as narrow bands of vegetation occurring in and along the margins of rivers, streams, or other drainages. Dominant species include white alder (*Alnus rhombifolia*) with occasional Oregon ash, red osier, big-leaf maple (*Acer macrophyllum*), narrowleaf willow, red willow, shining willow, and arroyo willow. Associated shrubs include spicebush, mock orange, California blackberry (*Rubus ursinus*), mugwort (*Artemisia douglasiana*), ninebark (*Physocarpus capitatus*), and western azalea (*Rhododendron occidentale*). Common lianas include California grape, pipevine (*Aristolochia californica*), greenbriar (*Smilax californica*), and virgin's bower (*Clematis ligusticifolia*). The ground layer is open to dense and is dominated by sedges with various grasses and forbs.

White Leaf Manzanita Chaparral White leaf manzanita is the most common chaparral plant series type in the Shasta Lake and vicinity portion of the primary study area and is scattered throughout all portions of the area. The dominant species is white leaf manzanita. Associated species include occasional common manzanita (A. manzanita), western redbud, buck brush, deer brush, poison oak, birch-leaf mountain-mahogany, interior live oak (shrub form), Fremont's silktassel, bush poppy, yerba santa, and Brewer's oak.

Upper Sacramento River (Shasta Dam to Red Bluff)

The following section provides a description of the wildlife habitats that exist throughout the primary study area, and a detailed discussion of potential Sacramento River downstream habitat restorations areas.

Plant Communities in the Primary Study Area (Shasta Dam to RBPP) The plant communities present in the primary study area between Shasta Dam and RBPP include common and sensitive communities as described below, and the relevant aspects of their ecology are discussed in detail in the *Botanical Resources and Wetlands Technical Report*, and summarized below for sensitive communities. These descriptions are generally applicable to the extended study area as well. (Plant community names and descriptions used in this section are based primarily on the Preliminary Descriptions of the *Terrestrial Natural Communities of California* (Holland 1986).)

Common plant communities present within the primary study area include annual grassland, chaparral, and agricultural lands. The upper banks along steep-sided, bedrock-constrained segments of the Sacramento River and its tributaries are characterized primarily by upland communities, including blue oak woodland, foothill pine-oak woodland, and chaparral. These segments occur primarily between Shasta Dam and Redding.

Sensitive plant communities include those that are of special concern to resource agencies or are afforded specific consideration through CEQA, Section 1602 of the California Fish and Game Code, Section 404 of the Federal Clean Water Act (CWA), and the State of California's (State) Porter-Cologne Water Quality Control Act, as discussed in Section 12.2, "Regulatory Framework."

Oak Woodlands Oak woodlands present in the primary study area include blue oak woodland, blue oak savanna, foothill pine-oak woodland, and valley oak woodland. The oaks that dominate the tree layer of oak savannas and woodlands are long-lived trees that are resilient to damage; their stems often survive fire, and when their stems are killed by fire or are cut down, basal sprouts often grow into new stems. (Valley oak also tolerates inundation during winter before it has leafed out.) Nonetheless, there are concerns regarding the status and ongoing trends of tree mortality and recruitment in tree canopies of blue oak- and valley oak-dominated savannas and woodlands (Tyler, Kuhn, and Davis 2006).

Riparian Communities California's riparian communities have experienced the most extensive reductions in their acreage, and in the Sacramento Valley more than 90 percent of riparian vegetation has been converted to agriculture or development, and the remainder substantially altered by dams, diversions, gravel mining, grazing practices, and invasive species (Hunter et al. 1999).

In the primary study area, much of the Sacramento River from Shasta Dam to Redding is deeply entrenched in bedrock, which precludes development of extensive areas of riparian vegetation. The river corridor between Redding and Red Bluff, however, still maintains extensive areas of riparian vegetation.

Riparian communities present within the floodplain of the Sacramento River, within the primary study area, include blackberry scrub, Great Valley willow scrub, Great Valley cottonwood riparian forest, Great Valley mixed riparian forest, and Great Valley valley oak riparian forest. Willow and blackberry scrub and cottonwood- and willow-dominated riparian communities are present along active channels and on the lower flood terraces whereas valley oak-dominated communities occur on higher flood terraces.

More than 15 native species of deciduous trees and shrubs occur in the riparian forests, woodlands, and scrubs of the Central Valley and the Delta (Conard, MacDonald, and Holland 1977; Vaghti and Greco 2007). Flow regime, disturbance, and species attributes determine the species composition and physical structure of this woody vegetation. Although flow regime influences the dispersal, establishment, growth, and survival of all the woody riparian species, Fremont's cottonwood (*Populus fremontii*) and the willow species (*Salix* sp.) particularly depend on specific hydrologic events for their recruitment. During seed release, flows must be high enough to disperse seed to surfaces where scouring by subsequent flows does not occur, yet not so high that seedlings desiccate after flows recede, and flows must recede gradually to enable germination and seedling establishment while the substrate is still moist (Mahoney and Rood 1998).

Fremont's cottonwood and willow species are rapidly growing, shade intolerant and relatively short-lived (Burns and Honkala 1990, Vaghti and Greco 2007). Within 10 to 20 years, initially shrubby thickets may reach 10–40 feet in height. Other species, such as Oregon ash (*Fraxinus latifolia*) and valley oak (*Quercus lobata*), establish concurrently or subsequent to the willows and cottonwood, grow more slowly but are more tolerant of shade, and are longer-lived (Burns and Honkala 1990, Tu 2000). In the absence of frequent disturbance, these species enter the canopy, particularly after 50 years, as mortality of willows and cottonwood frees space. Conversely, frequent disturbance prevents the transition to mature mixed riparian or valley oak forests.

The operation of Shasta Dam has limited the frequency, magnitude, and duration of intermediate and larger flows during fall and winter since the dam's construction, and flow volumes have been greater during the growing season. The operation of Shasta Dam also produces increasing flow volumes during the period of cottonwood seed dispersal (rather than flow volume decreasing during this period), largely precluding establishment of cottonwoods (and to a lesser extent willows) throughout much of the riparian zone (Roberts et al. 2002). The combined effect of these changes in flow regime has been a decrease in early- and mid-successional communities along the Sacramento River that is still ongoing (Fremier 2003).

Wetland Communities Similar to riparian communities, much of the wetland habitat that once occurred in the Sacramento River Valley has been eliminated as a consequence of land use conversion to agriculture and urbanization. It is estimated that nearly 1.5 million acres of wetlands once occurred in the Central Valley. Today, approximately 123,000 acres remain. Wetland communities that are likely to occur in the primary study area between Shasta Dam and RBPP include freshwater marsh, freshwater seep, northern hardpan vernal pools, northern volcanic mudflow vernal pools, and other seasonal wetlands.

Freshwater marshes are herbaceous wetland plant communities that occur along rivers and lakes and are characterized by dense cover of perennial, emergent plant species. Marshes are typically perennial wetlands, but may dry out for short periods of time. In marsh vegetation, vegetation structure and species richness are strongly influenced by disturbance, changes in water levels, and the range of elevations present at a site (Keddy 2000). Disturbances, and water level drawdowns that expose previously submerged surfaces, provide opportunities for species to establish, which creates diversity in species composition and vegetation structure. With increasing depth of water, the growth of marsh plants is reduced, and thus this vegetation type is typically restricted to shallow water.

Freshwater seep is a wetland plant community characterized by dense cover of perennial herb species usually dominated by rushes, sedges, and grasses. Freshwater seep communities occur on sites with permanently moist or wet soils resulting from daylighting groundwater.

Vernal pools are seasonal wetlands that fill during winter rains and dry up in spring. They occur in undulating or mima mound (i.e., mound-intermound) topography where the soil or underlying rock has layers that are relatively impermeable to water. Vernal pools may be isolated from one another, but more often they are interconnected by swales or ephemeral drainages in vernal pool complexes that may extend for hundreds of acres. Vernal pool complexes generally include water features. The two predominant types of vernal pool communities in the primary study area are northern hardpan vernal pools and northern volcanic mudflow vernal pools.

Pool size and the depth, duration, and seasonal timing of ponding are important factors that influence the composition and diversity of plant and animal species in vernal pools (Solomeshch, Barbour, and Holland 2007). Consequently, the vegetation of vernal pools can vary substantially from year to year in response to interannual fluctuations in climate.

Management activities such as grazing and burning also influence species composition and diversity. In fact, research indicates that the abundance of nonnative grasses, grazing practices, and hydrology are strongly interrelated and can substantially affect the plant communities of vernal pools (Robins and Vollmar 2002, Pyke 2004, Marty 2005).

Seasonal wetlands are ephemeral wetlands that pond or remain flooded for long periods during a portion of the year, generally the rainy winter season, then dry up, typically in spring. They often occur in shallow depressions on flood terraces that are occasionally to infrequently flooded. Seasonal wetlands are herbaceous communities typically characterized by species adapted for growth in both wet and dry conditions, and may contain considerable cover of upland species as well. Seasonal wetlands differ from vernal pools in that they do not have a restrictive hardpan layer and are usually dominated by nonnative plant species, especially nonnative grasses.

Potential Sacramento River Downstream Habitat Restoration Areas Many of the same plant community classifications found in the Shasta Lake and vicinity portion of the primary study area also occur in the potential Sacramento River habitat restoration areas. However, the species composition, structure, and overall function of these areas are significantly different, as these areas are situated in a separate geographic setting and region. Plant communities occurring in the potential Sacramento River habitat restoration areas include broom patches, black locust groves, California yerba santa scrub, cattail marshes, Fremont cottonwood forest, ghost pine woodlands, Hind's walnut stands, Oregon ash groves, sandbar willow thickets, shining willow groves, soft rush marshes, valley oak woodland, Wright's buckwheat patches, water primrose wetlands, white alder groves, and white-root beds. Other plant or habitat communities include California annual grassland, mixed riparian forest, parrot's feather mats, reed canarygrass swards, silver wattle thickets, barren, orchard, and riverine.

The potential Sacramento River downstream habitat restoration areas are characterized by habitats typical of riparian and riverine areas found in the Sacramento River below Shasta Dam. These habitats were also mapped and classified using the MCV. Habitats present in the potential Sacramento River downstream habitat restoration areas are summarized in Table 12-3 and depicted in Figures 12-4a through 12-4f. General habitat descriptions for these locations are also described below.

Table 12-3. Summary of Plant Communities in the Potential Sacramento River Downstream Restoration Areas

Habitat	Area (acres[1])						
	Henderson	Tobiasson Island	Shea Island Complex	Kapusta Island	Anderson River Park	Reading Island	Total
Broom patches	0.00	2.62	13.03	0.92	4.55	0.00	21.13
Black locust groves	0.00	0.00	0.35	0.00	0.00	0.00	0.35
California annual grassland	2.50	13.50	2.61	17.56	7.83	0.00	44.01
California yerba santa scrub	0.00	0.22	0.00	0.00	1.30	0.00	1.53
Cattail marshes	0.37	0.28	0.29	0.11	1.14	0.00	2.18
Foothill pine	0.00	13.26	0.70	1.86	0.00	0.00	15.82
Fremont cottonwood forest	7.05	1.04	0.00	4.79	44.26	0.00	57.14
Hind's walnut stands	0.42	0.00	0.00	0.00	0.00	0.00	0.42
Orchard	0.00	0.00	0.00	0.00	0.00	0.55	0.55

Table 12-3. Summary of Plant Communities in the Potential Sacramento River Downstream Restoration Areas (contd.)

Habitat	Area (acres*)						
	Henderson	Tobiasson Island	Shea Island Complex	Kapusta Island	Anderson River Park	Reading Island	Total
Oregon ash groves	0.00	0.00	0.00	0.00	2.57	0.00	2.57
Sandbar willow thickets	2.77	0.69	6.68	12.84	5.92	0.38	29.28
Shining willow groves	0.00	2.34	4.05	0.00	0.00	0.00	6.39
Silver wattle thickets	0.00	0.34	0.00	0.00	0.59	0.00	0.93
Soft rush marshes	0.00	0.00	0.26	0.00	0.00	0.00	0.26
Valley oak woodland	2.88	2.03	3.50	14.46	26.85	50.48	100.19
Wright's buckwheat patches	0.00	0.00	0.00	0.00	1.49	0.00	1.49
Water primrose wetlands	3.36	0.00	0.00	0.00	5.81	15.33	24.50
White alder groves	0.00	0.00	0.22	4.16	0.00	0.00	4.38
White-root beds	0.00	0.00	0.00	0.18	0.00	0.00	0.18
Mixed riparian forest	0.00	0.00	0.00	0.00	0.00	24.40	24.40
Parrot's feather mats	0.00	0.00	0.00	0.00	2.92	0.00	2.92
Reed canarygrass swards	0.00	0.00	0.44	0.32	1.18	0.00	1.95
Barren[2]	0.31	1.10	0.00	0.00	0.55	0.00	1.96
Riverine[2]	0.66	1.33	3.45	8.13	0.00	0.47	14.04
Total	20.32	38.76	35.57	65.33	106.96	91.61	358.56

Note:
[1] Acreage values are approximate.
[2] California Wildlife Habitat Relationships Wildlife Habitat Type; no corresponding plant series type included in *A Manual of California Vegetation* (Sawyer et al. 2009).

This page left blank intententionally.

Figure 12-4a. Manual of California Vegetation Types – Henderson Open Space

This page left blank intentionally.

Figure 12-4b. Manual of California Vegetation Types – Tobiasson Island

This page left blank intentionally.

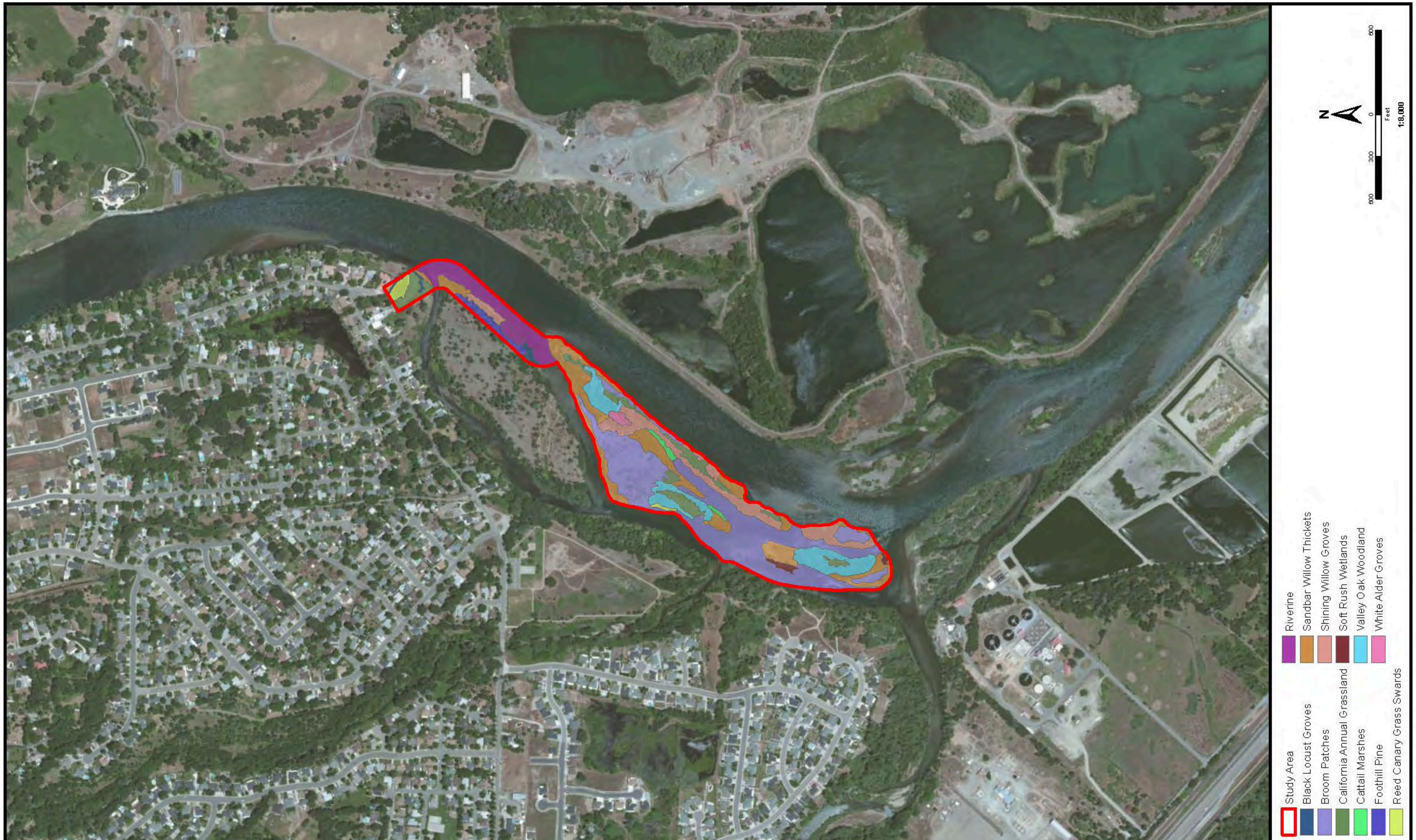


Figure 12-4c. Manual of California Vegetation Types – Shea Island Complex

This page left blank intentionally.

Figure 12-4d. Manual of California Vegetation Types – Kapusta Island

This page left blank intentionally.

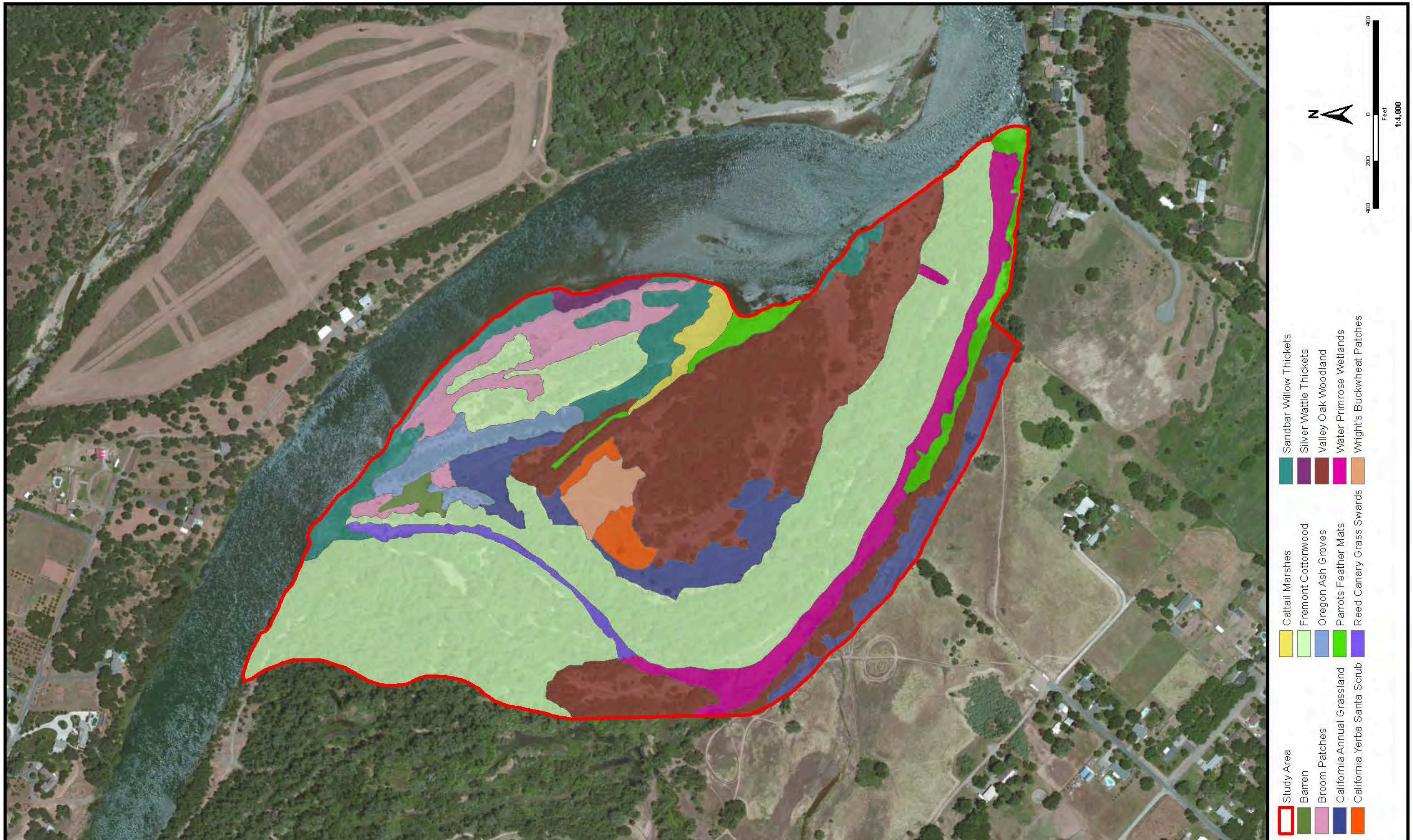


Figure 12-4e. Manual of California Vegetation Types – Anderson River Park

This page left blank intentionally.

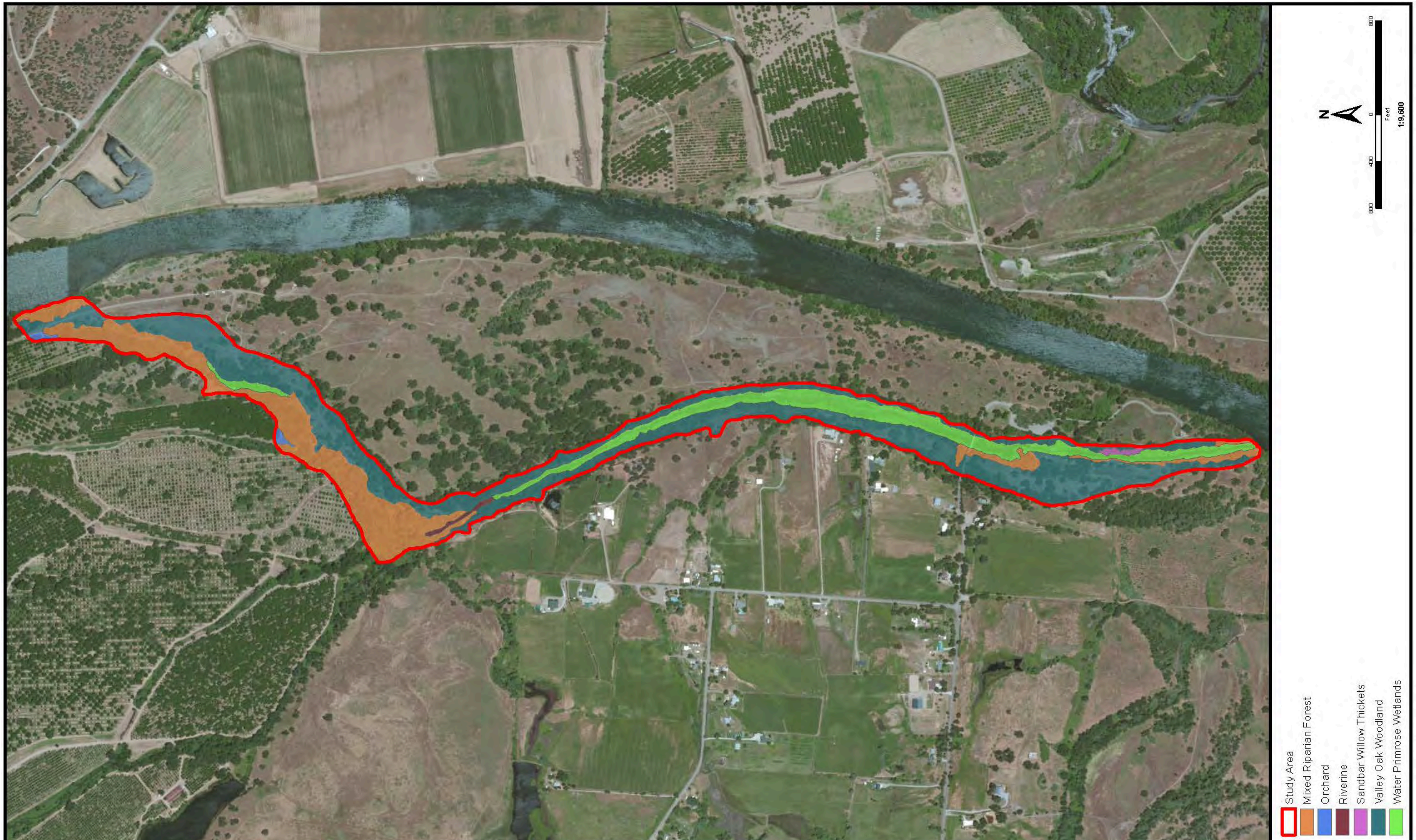


Figure 12-4f. Manual of California Vegetation Types – Reading Island

This page left blank intentionally.

Broom Patches Broom patches mainly occur on open gravel bars and are characterized by sparse to dense patches of Spanish broom (*Spartium junceum*). Associated species include Bermuda grass (*Cynodon dactylon*), Oregon golden aster (*Heterotheca oregona*), gumweed (*Grindelia* sp.), and common ragweed (*Ambrosia artemisiifolia*).

Black Locust Groves Black locust groves are an uncommon plant community in the potential restoration sites and occur as small stands at the Shea Island Complex site. This community is characterized by a moderate to dense canopy of black locust with occasional valley oak. The dominant understory vegetation is Himalayan blackberry.

California Yerba Santa Scrub California yerba santa scrub occurs on open rocky areas and is characterized by sparse to moderate cover of California yerba santa. Sparse annual grasses and forb cover also occurs in these areas including Oregon golden aster, wright's buckwheat (*Eriogonum wrightii*), naked buckwheat (*Eriogonum nudum*), slender wild oat (*Avena barbata*), mousetail (*Myosurus* sp.), ripgut grass (*Bromus diandrus*), soft chess (*Bromus hordeaceus*), and red brome (*Bromus madritensis* ssp. *rubens*).

Cattail Marshes Cattail marshes occur along the margins of backwater sloughs, pond margins, and as small inclusions in riparian forests. This plant community is characterized by dense stands of broadleaf cattail (*Typha latifolia*). Within the shallow fringes of these cattail marshes are small patches of reed canarygrass (*Phalaris arundinacea*), horsetail (*Equisetum* sp.), rush (*Juncus* sp.), and dallisgrass (*Paspalum dilatatum*). Parrot's feather (*Myriophyllum aquaticum*), smartweed (*Persicaria* sp.) and water primrose (*Ludwigia peploides*) grow in the deep water areas of the marshes.

Fremont Cottonwood Forest Fremont cottonwood forest occurs as multi-layered riparian forest stands characterized by a moderate to dense canopy of predominantly Fremont cottonwood. Associated species including valley oak, Oregon ash, white alder, narrowleaf willow, shining willow, Goodding's black willow, black locust (*Robinia pseudoacacia*), and silver wattle (*Acacia dealbata*) are also present in the canopy layer. Dominant understory vegetation includes Himalayan blackberry, California grape, Santa Barbara sedge (*Carex barbarae*), giant reed (*Arundo donax*), mugwort (*Artemisia douglasiana*), horsetail, Bermuda grass (*Cynodon dactylon*), and Johnson grass (*Sorghum halepense*).

Ghost Pine Woodland Ghost pine woodlands occur in upland areas above the active floodplain and are characterized by a moderately dense canopy of foothill pine with occasional valley oak and Fremont cottonwood. Dominant understory species include Himalayan blackberry and Spanish broom.

Hind's Walnut Stands Hind's walnut and related stands occur as a small stand of riparian trees in the southeast portion of the Henderson Open Space potential restoration site. This semi-natural stand is dominated by an overstory of black walnut (*Juglans nigra*) with occasional valley oak and narrowleaf willow. Understory vegetation is moderately dense and includes Himalayan blackberry, California grape, Johnson grass, and Bermuda grass.

Oregon Ash Groves Oregon ash groves are an uncommon plant community in the potential restoration sites and are characterized by a moderately dense canopy of Oregon ash. Associated tree species include Fremont cottonwood, shining willow, and narrowleaf willow. Dominant shrub species include French broom (*Genista monspessulana*), giant reed, and Himalayan blackberry. The herbaceous layer is dominated by Bermuda grass.

Sandbar Willow Thickets Sandbar willow thickets occur in riparian habitats throughout the study area. This plant community is characterized by a moderate to dense canopy of narrowleaf willow. Associated trees and shrubs include shining willow, Fremont cottonwood, Goodding's black willow, Oregon ash, black walnut, black locust, and Himalayan blackberry. The herbaceous layer consists of primarily broomsedge bluestem (*Andropogon virginicus*), horsetail, rushes, nut sedges (*Cyperus* spp.), dallisgrass, and Johnson grass.

Shining Willow Groves Shining willow groves are an uncommon plant community in the potential restoration sites and are characterized by dense stands of shining willow with occasional narrowleaf willow, Himalayan blackberry, and California grape.

Soft Rush Marshes Soft rush marshes are an uncommon wetland plant community in the potential restoration sites and occur in patches along the shallow margins of the Sacramento River. This plant community is characterized by dense cover of soft rush (*Juncus effusus*) with occasional Santa Barbara sedge, reed canarygrass, nut sedge (*Cyperus eragrostis*), and spikerush (*Eleocharis* sp.).

Valley Oak Woodland Valley oak woodland occurs in portions of the potential restoration sites above the active floodplain of the Sacramento River. This plant community is characterized by a moderately dense canopy of valley oak with some interior live oak, foothill pine, narrowleaf willow, shining willow, black locust, Fremont cottonwood, black willow, Oregon ash, and tree of heaven (*Ailanthus altissima*) scattered throughout. Dominant understory vegetation includes western redbud, California coffee berry (*Frangula californica*), mugwort, winter vetch (*Vicia villosa*), Santa Barbara sedge, ripgut grass, common ragweed, California grape, California pipevine, and Bermuda grass.

Wright's Buckwheat Patches Wright's buckwheat patches occur in open rocky areas and are characterized by sparse to moderate cover of Wright's buckwheat. Sparse cover of annual grasses and forbs also occur in these areas including Oregon golden aster, naked buckwheat, slender wild oat, mousetail, ripgut grass, soft chess, and red brome.

Water Primrose Wetlands Water primrose wetlands occur in sloughs, backwater marshes, and along pond margins. These wetlands are characterized by dense mats of water primrose (*Ludwigia peploides*) with parrot's feather, smartweed (*Persicaria* sp.), and broadleaf cattail.

White Alder Groves White alder groves occur as multi-layered stands along the river margins characterized by a moderate to dense canopy of white alder. Associated species include Fremont cottonwood, shining willow, narrowleaf willow, black locust, valley oak, Oregon ash, and box elder. Dominant understory vegetation includes Himalayan blackberry, Santa Barbara sedge, mugwort, horsetail, verbena, water iris, and rush.

White-Root Beds White-root beds occur as small inclusions in riparian forest habitats. This plant community is characterized by dense patches of Santa Barbara sedge with occasional Himalayan blackberry, verbena, horsetail, and goose grass (*Galium aparine*).

California Annual Grasslands California annual grasslands are uncommon in the study area and occur as open ruderal areas and vegetated gravel bars. This plant community is characterized by moderate to dense cover of annual grasses and forbs including black mustard (*Brassica nigra*), California poppy (*Eschscholzia californica*), ripgut grass, soft chess, wild oat, rose clover (*Trifolium hirtum*), long beaked storks bill (*Erodium botrys*), turkey mullein (*Croton setigeris*), Oregon golden aster, and tall sock-destroyer (*Torilis arvensis*).

Mixed Riparian Forest Mixed riparian forest occurs at the Reading Island potential restoration site and consists of moderate to dense stands of riparian trees and shrubs. A diverse assemblage of tree species occur including valley oak, narrowleaf willow, Goodding's black willow, shining willow, white alder, black walnut, tree of heaven, box elder, black locust, California buckeye, and blue elderberry (*Sambucus nigra* ssp. *caerulea*). Dominant understory species include buttonbush, Himalayan blackberry, California grape, California pipevine, mugwort, Santa Barbara sedge, and California man-root (*Marah fabacea*).

Parrot's Feather Mats Parrot's feather mats occur in sloughs and backwater marshes. This vegetation type is characterized by dense patches of parrot's feather with small inclusions of water primrose, smartweed, and broadleaf cattail.

Reed Canarygrass Swards Reed canarygrass swards occur in sloughs and backwater areas in the study area. This semi-natural stand is characterized by moderate to dense cover of reed canarygrass. Associated species include narrowleaf willow, broadleaf cattail, smartweed, sedges, and rushes.

Silver Wattle Thickets Silver wattle thickets are an uncommon plant community in the potential restoration sites and occur as small riparian stands in the northern portion of Tobiasson Island. This plant community is characterized by a moderate to dense canopy of silver wattle. Associated species include Oregon ash, Fremont cottonwood, black locust, giant reed, horsetail, and Bermuda grass.

Barren Barren habitat occurs on gravel bars and is characterized by open areas of gravel and cobble substrates. Vegetation is typically absent, although in some barren areas sparse opportunistic grasses/forbs or weedy species may occur.

Orchard Orchard habitat is uncommon in the potential Sacramento River habitat restoration areas and only occurs at the Reading Island site. This habitat consists of a small portion of a walnut orchard extending into a portion of the northern site boundary. The walnut orchard is mature and well maintained. Vegetation includes an overstory of walnut trees and ground cover of various grasses and forbs.

Riverine Riverine habitat occurs at each potential Sacramento River habitat restoration area and consists of portions of active Sacramento River channel within and/or around each site. The riverbed is dominated by primarily gravel, cobble, and boulder substrates.

Lower Sacramento River and Delta

A large number of natural plant communities occur in the extended study area, and some are described in this section and the “CVP/SWP Service Areas” section, or in the *Botanical Resources and Wetlands Technical Report*. The other natural plant communities are described in the following sections, and in Mayer and Laudenslayer (1988), Sawyer and Keeler-Wolf (1995), and CALFED (2000a). In addition to natural plant communities, plant communities of agricultural and urban areas occupy extensive portions of the extended study area.

The lower Sacramento River can be subdivided into distinct reaches that differ in topography, hydrology, and geomorphology; and thus, in vegetation and associated habitat functions.

Red Bluff Pumping Plant to Colusa

In this reach, the Sacramento River is classified as a meandering river, where relatively stable, straight sections alternate with more sinuous, dynamic sections (Resources Agency 2003). The channel remains active and has the potential to migrate in times of high water. Point bars, islands, high and low terraces, instream woody cover, early-successional riparian plant growth, and other evidence of river meander and erosion are common in this reach. Major physiographic features include floodplains, basins, terraces, active and remnant channels, and oxbow sloughs. These features sustain a diverse array of riparian plant communities.

Colusa to the Delta

The general character of the Sacramento River changes quite drastically downstream from Colusa from a dynamic and active meandering channel to a confined, narrow channel restricted from migration. Surrounding agricultural lands encroach directly adjacent to the levees, which have cut the river off from most of its riparian corridor, especially on the eastern side of the river. Most of the levees in this reach are lined with riprap, allowing the river no erodible substrate and limiting the extent of riparian vegetation.

Primary Tributaries to the Lower Sacramento River

The primary tributaries of the lower Sacramento River are the Feather River, American River, and Sacramento River floodplain bypasses. The aquatic ecosystem in the lower Feather River, down to the confluence with the Sacramento River at Verona, is influenced by DWR's Oroville Facilities. The upper extent is fairly confined by levees as the river flows through the city of Oroville. Downstream from Oroville, the Feather River is fairly active and meanders its way south to Marysville. However, this stretch is bordered by active farmland, which confines the river into an incised channel in certain stretches and limits the width of riparian woodland. Some of this adjacent farmland is in the process of being restored to floodplain habitat with the relocation of levees to become setback levees.

The lower American River (below Folsom and Nimbus dams) is fairly low gradient. Most of the lower American River is surrounded by the American River Parkway, which preserves the surrounding riparian zone. The river channel does not migrate to a large degree because it has become deeply incised, leaving tall cliffs and bluffs adjacent to the river.

Multiple water diversion structures in the lower Sacramento River move floodwaters into floodplain bypass areas during high-flow events. These floodplain bypass areas – the Butte basin, Sutter Bypass, and Yolo Bypass – provide broad, inundated floodplain habitat during wet years. Unlike other Sacramento River and Delta habitats, floodplains and floodplain bypasses are seasonally dewatered (as high flows recede). Their predominant communities include grassland, seasonal wetlands, and agricultural vegetation.

Sacramento-San Joaquin River Delta

The Delta comprises an area of approximately 750,000 acres divided into a number of islands by hundreds of miles of waterways. Before reclamation, the Delta was inundated each year by winter and spring runoff, which changed channel geometry in response to flood conditions and tidal influence. Consequently, there were extensive areas of marsh in the Delta.

Nearly all of the Delta's marshland has since been reclaimed by agriculture, peat production, and urban and industrial uses. More than 1,000 miles of levees protect this reclaimed land (CALFED 2000b). However, some small islands remain in a quasinatural state, as do some other areas with aquatic and wetland communities (e.g., "flooded islands" that were once reclaimed land, but have been abandoned after levee failures). The species composition and ecology of these riparian, marsh, and aquatic plant communities differ from the composition and ecology of communities in the upper and lower Sacramento River portions of the combined primary and extended study areas and are described below.

Along the lower Sacramento River and in the Delta, riparian vegetation is characterized by narrow linear strips of trees and shrubs, in single- to multiple-story canopies. Tree canopies may be continuous or discontinuous, or absent altogether (as in riparian scrubs). These patches of riparian vegetation may be on or at the toe of levees (particularly in the Delta). Riparian communities in this region include cottonwood-willow woodland, Valley oak riparian woodland, riparian scrub, and willow scrub. These communities are described below.

The dynamics of riparian communities along the lower Sacramento River and in the Delta are similar to those described for riparian communities along the upper Sacramento River. However, along the Sacramento River south of Colusa, in the flood bypasses, and in the Delta, the disturbances that remove riparian vegetation, or create newly exposed surfaces where riparian vegetation can establish, differ somewhat from those along the upper Sacramento River. In these downstream areas, disturbances related to meander migration are more limited, and anthropogenic (human-caused) disturbances, such as levee maintenance and trampling, are greater than those upstream. This is because of the close proximity to levees, extensive placement of bank protection, and greater human population.

In addition to the wetland communities described for the upper Sacramento River, the Delta has tidal freshwater and brackish-water emergent marshes that, like nontidal marshes, are dominated by clonal perennial plants. This community occurs on instream islands and along tidally influenced waterways. In addition to the environmental factors affecting nontidal marshes, the species composition of tidal marshes in the Delta is also affected by regional salinity gradients.

The Delta also supports extensive areas of aquatic vegetation. These communities consists of submerged plants generally rooted in the substrate, whose stems may partially extend above the water surface (e.g., during flowering) and floating plants that are generally not rooted in the substrate. The availability of light (which decreases with depth), turbidity, and shade cast by overtopping vegetation can restrict submerged plants to relatively shallow areas. In the Delta (which has turbid waters), most submerged vegetation appears to be restricted to areas less than 5–10 feet deep. The velocity of flows may contribute to this depth restriction.

CVP/SWP Service Areas

Although agricultural and urban land uses have substantially reduced the area and connectivity of natural vegetation, the service areas still contain a large diversity of both lowland and upland plant communities, including many sensitive plant communities (see the *Botanical Resources and Wetlands Technical Report*). The most dramatic difference between historical and existing conditions is the fragmentation of what were once large contiguous blocks of habitat. Significant changes to the natural landscape in the region occurred in the late 1800s and early 1900s with land conversions to agriculture. However, in Southern California, that pattern shifted dramatically compared to the pattern in the Central Valley, as urban growth in the region that started in the 1900s began to convert large areas of agricultural lands and of remaining natural vegetation to developed land uses.

12.1.2 Special-Status Species

Special-status species addressed in this section include plants that are legally protected or are otherwise considered sensitive by Federal, State, or local resource conservation agencies and organizations. These include species that are State listed and/or Federally listed as rare, threatened, or endangered; those considered as candidates or proposed for listing as threatened or endangered; species identified by CDFW as Species of Special Concern or USFS as sensitive, endemic, or needing additional survey or management actions; and plants considered jointly by CDFW and CNPS to be rare, threatened, or endangered; and species afforded protection under local planning documents, including the CALFED Bay-Delta Program’s (CALFED) Multi-Species Conservation Strategy (MSCS).

Shasta Lake and Vicinity

Within the Shasta Lake and vicinity portion of the primary study area are a wide variety of vegetative communities and habitat components that support a large diversity of plant species. To aid in determining the potential impacts of the project, a list of potential plant species of concern was developed.

For the purposes of this evaluation, botanical species of concern are plants, lichen, and fungi that fall into any of the following categories:

- Designated as rare or listed as threatened or endangered by the State or Federal government
- Proposed for designation as rare or listing as threatened or endangered by the State or Federal government
- Candidate species for State or Federal listing as threatened or endangered
- Ranked as California Rare Plant Rank (CRPR) 1A, 1B, 2, 3, or 4 (formerly CNPS List 1A, 1B, 2, 3, or 4)

- Considered sensitive or Forest Plan Endemic by the USFS
- Considered a Northwest Forest Plan Survey and Manage (S&M) species by the USFS or U.S. Department of the Interior, Bureau of Land Management (BLM)
- Designated as an MSCS covered species by CALFED (see California Bay-Delta Authority, Section 12.2.4).

Potentially occurring plant species of concern were determined by performing several database searches, reviewing USFWS and CDFW special-status species lists for Shasta County, reviewing other appropriate literature, discussions with resource agency personnel, and professional experience in the region. Additionally, results from the various vegetation habitat mapping efforts, botanical surveys, and wildlife surveys conducted in the area by Reclamation since 2002 were used in developing the list of species of concern.

Table 12-4 summarizes special-status plant species identified as having a potential to occur in the Shasta Lake and vicinity portion of the primary study area. Potentially occurring special-status plant species in the potential Sacramento River downstream restoration sites are summarized in Table 12-5.

Table 12-4. Plant Species of Concern with Potential to Occur in the Shasta Lake and Vicinity Portion of the Primary Study Area

Common Name	Scientific Name	Status[1]
Shasta ageratina	*Ageratina shastensis*	CRPR 1B.2, FPE
Sanborn's onion	*Allium sanbornii* var. *sanbornii*	CRPR 4.2
Bent-flowered fiddleneck	*Amsinckia lunaris*	CRPR 1B.2, BLMS
Mallory's manzanita	*Arctostaphylos malloryi*	CRPR 4.3
Shasta County arnica	*Arnica venosa*	CRPR 4.2, FPE
Marbled ginger	*Asarum marmoratum*	CRPR 2B.3
Depauperate milk-vetch	*Astragalus pauperculus*	CRPR 4.3
Moonwort, grape-fern	*Botrychium subgenus Botrychium*	USFS S, S&M
Yellow-twist horsehair	*Bryoria tortuosa*	BLMS
Green bug moss	*Buxbaumia viridis*	USFS S, BLMS, S&M
Callahan's mariposa lily	*Calochortus syntrophus*	CRPR 1B.1
Butte County morning-glory	*Calystegia atriplicifolia ssp. buttensis*	CRPR 4.2
Castle Crags harebell	*Campanula shetleri*	CRPR 1B.3, USFS S, BLM S
Buxbaum's sedge	*Carex buxbaumii*	CRPR 4.2
Bristly sedge	*Carex comosa*	CRPR 2B.1, MSCS r
Shasta clarkia	*Clarkia borealis ssp. arida*	CRPR 1B.1, MSCS m, BLM S
Northern clarkia	*Clarkia borealis ssp. borealis*	CRPR 1B.3, BLM S
Silky cryptantha	*Cryptantha crinita*	CRPR 1B.2, MSCS m, BLM S
California lady's-slipper	*Cypripedium californicum*	CRPR 4.2

Table 12-4. Plant Species of Concern with Potential to Occur in the Shasta Lake and Vicinity Portion of the Primary Study Area (contd.)

Common Name	Scientific Name	Status[1]
Clustered lady's-slipper	*Cypripedium fasciculatum*	CRPR 4.2, USFS S, BLM S, S&M
Mountain lady's-slipper	*Cypripedium montanum*	CRPR 4.2, USFS S, BLM S, S&M
Four-angled spike rush	*Eleocharis quadrangulata*	MSCS m
Shasta limestone monkeyflower	*Erythranthe taylori*	CRPR 1B.1
	Erythronium sp. *nov*.	New species of fawn lilly endemic to Shasta Lake region; occurs in shady, northerly aspect forest habitats and below limestone outcrops; taxonomic treatment in preparation. Considered a special-status species for the purposes of this evaluation.
Butte County fritillary	*Fritillaria eastwoodiae*	CRPR 3.2, USFS S
Dubious pea	*Lathyrus sulphureus* var. *argillaceus*	CRPR 3
Broad-lobed linanthus	*Leptosiphon latisectus*	CRPR 4.3
Cantelow's lewisia	*Lewisia cantelovii*	CRPR 1B.2, USFS S, BLM S
Howell's lewisia	*Lewisia cotyledon* var. *howellii*	CRPR 3.2
Bellinger's meadowfoam	*Limnanthes floccosa* ssp. *bellingeriana*	CRPR 1B.2, MSCS m, BLM S
Awl-leaved navarretia	*Navarretia subuligera*	CRPR 4.3
Shasta snow-wreath	*Neviusia cliftonii*	CRPR 1B.2, USFS S, MSCS m, BLM S
Thread-leaved beardtongue	*Penstemon filiformis*	CRPR 1B.3, MSCS m, BLM S
Narrow-petaled rein orchid	*Piperia leptopetala*	CRPR 4.3
Bidwell's knotweed	*Polygonum bidwelliae*	CRPR 4.3
Eel-grass pondweed	*Potamogeton zosteriformis*	CRPR 2B.2, MSCS m
Pacific fuzzwort	*Ptilidium californicum*	BLM S, S&M
Hoary gooseberry	*Ribes roezlii* var. *amictum*	CRPR 4.3
Bug on a stick	*Schistostega pennata*	S&M
Brownish beaked-rush	*Rhynchospora capitellata*	CRPR 2B.2
Sanford's arrowhead	*Sagittaria sanfordii*	CRPR 1B.2, MSCS m, BLM S
Marsh skullcap	*Scutellaria galericulata*	CRPR 2B.2, MSCS m
Canyon Creek stonecrop	*Sedum obtusatum* ssp. *paradisum*	CRPR 1B.3, USFS S, BLM S
English Peak greenbriar	*Smilax jamesii*	CRPR 1B.3, MSCS m, BLM S

Table 12-4. Plant Species of Concern with Potential to Occur in the Shasta Lake and Vicinity Portion of the Primary Study Area (contd.)

[1] NoteS:
Status Codes
S&M = Survey and Manage Species
CRPR 2 = Plants rare, threatened, or endangered in California but more common elsewhere (includes rare plant ranks 2B.1, 2B.2, and 2B.3)
CRPR 3 = Plants for which more information is need – a review list
CRPR 4 = Plants of limited distribution – a watch list
CRPR Threat Ranks
0.1 = Seriously threatened in California
0.2 = Fairly threatened in California
0.3 = Not very threatened in California

MSCS (Multi Species Conservation Strategy) covered species
R = Recovery. Recover species' populations within the MSCS focus area to levels that ensure the species' long-term survival in nature.
r = Contribute to recovery. Implement some of the actions deemed necessary to recover species' populations within the MSCS focus area.
m = Maintain. Ensure that any adverse effects on the species that could be associated with implementation of CALFED actions will be fully offset through implementation of actions beneficial to the species (CALFED 2000c).

Key:
BLMS = BLM sensitive
CRPR = California Rare Plant Rank
USFS = U.S. Forest Service
FPE = USFS Forest Plan Endemic Species
USFS S = USFS Sensitive Species
S&M = Survey and Manage Species
MSCS = Multi Species Conservation Strategy

Table 12-5. Plant Species of Concern with Potential to Occur in the Potential Sacramento River Downstream Restoration Sites

Common Name	Scientific Name	Status[1]
Red-flowered bird's-foot trefoil	*Acmispon rubriflorus*	CRPR 1B.1, BLM S
Henderson's bent grass	*Agrostis hendersonii*	CRPR 3.2, MSCS m
Cleveland's milk-vetch	*Astragalus clevelandii*	CRPR 4.3
Jepson's milk-vetch	*Astragalus rattanii var. jepsonianus*	CRPR 4.3, BLM S
Big-scale balsamroot	*Balsamorhiza macrolepis*	CRPR 1B.2, BLM S
Sulphur Creek brodiaea	*Brodiaea matsonii*	CRPR 1B.1
Bristly sedge	*Carex comosa*	CRPR 2B.1, MSCS r
Silky cryptantha	*Cryptantha crinita*	CRPR 1B.2, BLM S, MSCS m
Four-angled spikerush	*Eleocharis quadrangulata*	MSCS m
Boggs Lake hedge-hyssop	*Gratiola heterosepala*	CE, CRPR 1B.2, BLM S, MSCS m
California satintail	*Imperata brevifolia*	CRPR 2B.1
Red Bluff dwarf rush	*Juncus leiospermus var. leiospermus*	CRPR 1B.1, BLM S, MSCS m
Bellinger's meadowfoam	*Limnanthes floccosa ssp. bellingeriana*	CRPR 1B.2, BLM S, MSCS m
Shield-bracted monkeyflower	*Mimulus glaucescens*	CRPR 4.3

Table 12-5. Plant Species of Concern with Potential to Occur in the Potential Sacramento River Downstream Restoration Sites (contd.)

Common Name	Scientific Name	Status[1]
Slender Orcutt grass	*Orcuttia tenuis*	FT, CE, CRPR 1B.1, MSCS m
Ahart's paronychia	*Paronychia ahartii*	CRPR 1B.1, BLM S, MSCS m
Sanford's arrowhead	*Sagittaria sanfordii*	CRPR 1B.2, BLM S, MSCS m
Greene's Tuctoria	*Tuctoria greenei*	FE, CR, CRPR 1B.1, MSCS m

Notes:
[1] Status Codes
CE = California endangered
CR = California rare
FE = Federally endangered
FT = Federally threatened
CRPR (California Rare Plant Rank)
CRPR 1B = Plants rare, threatened, or endangered in California and elsewhere (includes rare plant ranks 1B.1, 1B.2, and 1B.3)
CRPR 2A, 2B = Plants rare, threatened, or endangered in California but more common elsewhere (includes rare plant ranks 2B.1, 2B.2, and 2B.3)
CRPR 3 = Plants for which more information is need – a review list
CRPR 4 = Plants of limited distribution – a watch list
CRPR Threat Ranks
0.1 = Seriously threatened in California
0.2 = Fairly threatened in California
0.3 = Not very threatened in California

BLM (Bureau of Land Management):
S = Sensitive
MSCS (Multi Species Conservation Strategy) covered species
R = Recovery. Recover species' populations within the MSCS focus area to levels that ensure the species' long-term survival in nature.
r = Contribute to recovery. Implement some of the actions deemed necessary to recover species' populations within the MSCS focus area.
m = Maintain. Ensure that any adverse effects on the species that could be associated with implementation of CALFED actions will be fully offset through implementation of actions beneficial to the species (CALFED 2000c).
Key:
CRPR = California Rare Plant Rank
MSCS = Multi Species Conservation Strategy

The CNDDB was reviewed for records of special-status plant species in or near the Shasta Lake and vicinity portion of the primary study area. The CNDDB is a database consisting of historical observations of special-status plant species, wildlife species, and natural communities. The CNDDB is limited to reported sightings and is not a comprehensive list of special-status species that may occur in a particular area.

A search of the CNPS Electronic Inventory was also conducted. The Electronic Inventory allows users to query the database using a set of variable search criteria. The result of the search is a list of potentially occurring special-status plant species. The criteria used for the query included all CRPR 1A, 1B, 2A, 2B, 3, and 4 plants occurring in Shasta County in closed-cone coniferous forest, chaparral, cismontane woodland, lower montane coniferous forest, marshes and swamps, pebble plain, valley and foothill grasslands, riparian forest, riparian woodland, and riparian scrub habitats between the elevations of approximately 900 feet and 2,500 feet.

Botanical Surveys Reclamation conducted several botanical surveys for special-status plant species in the Shasta Lake and vicinity portion of the primary study area. Botanical surveys were conducted in between 2002 and 2014. A list of species observed during the surveys is provided as Attachment 2 to the Botanical Resources and Wetlands Technical Report in the Biological Resources Appendix. Detailed survey information is provided as Attachment 6 to the Botanical Resources and Wetlands Technical Report in the Biological Resources Appendix. Baldwin et al. (2012) is used as the standard reference for taxonomic nomenclature and identification.

Botanical surveys were performed during 2002 along the Big Backbone and Squaw Creek arms. In 2003, botanical surveys were conducted along 11 selected riverine reaches: Little Backbone Creek, Sugarloaf Creek, upper Sacramento River, middle Salt Creek, Salt Creek, Nosoni Creek, Dekkas Creek, Campbell Creek, Flat Creek, Ripgut Creek, and Potem Creek. The surveys were conducted in general accordance with the technical methods prescribed in *California Department of Fish and Wildlife Protocols for Surveying and Evaluating Impacts to Special Status Plant Populations and Natural Plant Communities* (California Department of Fish and Game 2009), except that only portions of the project area have been surveyed . In 2004, botanical surveys were conducted at a series of randomly and nonrandomly selected locations. Nonrandomly selected sites were located throughout the Shasta Lake and vicinity portion of the primary study area (not including relocation areas) based on 2002 and 2003 survey results. Sites were selected based on the presence of unique habitat and ecological attributes, such as recently burned areas, unique geologic substrates, late-seral forests, and uncommon plant series. Nonrandomly selected sites varied in size and often included several plant series types. Randomly selected sites were selected throughout the area using plant series polygons developed from previously completed vegetation mapping. Using the geographic information system (GIS), individual vegetation polygons were assigned a unique number, and 100 numbers (i.e., vegetation polygons) were then randomly selected.

Based on previous surveys resulting in discoveries of Shasta snow-wreath (*Neviusia cliftonii*) and Shasta huckleberry (*Vaccinium* sp. *nov*), specific surveys for these species have been conducted since 2009. These surveys were designed to identify potential habitat for and locate populations of these species outside of the proposed project area. Pedestrian surveys were conducted to search the focus areas identified. Using methods described in Lindstrand and Nelson (2006), potential survey areas were identified using soil and geologic information at known sites and choosing areas with those same characteristics. In addition, survey sites were identified using intuitive techniques, such as selecting areas with vegetative cover types similar to those of known populations and areas near known populations (regardless of vegetative cover).

A genetic study of the Shasta snow-wreath was conducted in 2009 and 2010 to help determine potential project impacts and evaluate potential mitigation measures. The goal of the genetic study was to (1) determine whether all Shasta snow-wreath populations are genetically identical, (2) determine whether there are several homogeneous population clusters, or (3) determine whether some other pattern is present. Twenty-one of the 23 Shasta snow-wreath occurrences known at the time were included in the study. The genetic study determined that the species is characterized by low genetic diversity and high levels of genetic differentiation (National Forest Genetics Laboratory 2010, DeWoody et al. 2012). No strong patterns were found between the Shasta snow-wreath populations and several physical and geographic variables, including soil, geology, population size, and geographic location. Although high levels of genetic differentiation and no strong population patterns are present, the genetic study found three general population clusters, providing insight and basic species information for potential mitigation planning.

A separate genetic study was conducted in 2009, 2010, and 2013 to describe the genetics of Shasta *Vaccinium* (huckleberry). The goal of the study was to determine if the Shasta *Vaccinium* was different genetically from coastal and Sierra Nevada *Vaccinium* populations and, if so, to determine if it warrants recognition as a new taxon. The genetic study determined that the species is genetically distinct from the other *Vaccinium* populations (National Forest Genetics Laboratory 2010, DeWoody et al. 2012b, National Forest Genetics Laboratory 2014). Based on the results of the genetic study combined with distinct morphologic and ecologic characteristics, the Shasta huckleberry appears to be an uncommon and geographically restricted species and warrants recognition as a new taxon. The taxonomic treatment is in preparation.

Between 2010 and 2014, botanical surveys were conducted in all relocation areas, including the dam footprint. The surveys were conducted in general accordance with the *California Department of Fish and Wildlife Protocols for Surveying and Evaluating Impacts to Special Status Plant Populations and Natural Plant Communities* (California Department of Fish and Game 2009).

Eight special-status plant species were found during the survey efforts and/or incidentally during other technical studies: Shasta County arnica (*Arnica venosa*), Northern clarkia (*Clarkia borealis* ssp. *borealis*), Cantelow's lewisia (*Lewisia cantelovii*), Shasta snow-wreath, slender false lupine (*Thermopsis gracilis* var. *gracilis*), Shasta huckleberry, and oval-leaved viburnum (*Viburnum ellipticum*), and Shasta limestone monkeyflower (*Erythranthe taylorii*).

One population of Shasta County arnica was found in ponderosa pine habitat south of Bridge Bay Resort along the Main Body and another near the privately owned cabins on USFS lands in the Salt Creek inlet on the Sacramento Arm.

Additionally, USFS has located a population along the Sacramento Arm north of Slaughterhouse Island during surveys conducted in 2010 (Figure 12-5a and 12-3c).

One population of northern clarkia was found in hardwood-conifer/chaparral habitat near Bailey Cove on the McCloud Arm, and another population was found in hardwood-conifer/chaparral habitat in Sugarloaf Cove west of Beehive Point on the Sacramento Arm. The northern clarkia locations are shown in Figures 12-5c through 12-5d.

One population of Cantelow's lewisia was discovered on a rock outcrop on the right bank of the upper Sacramento River near the Shasta Lake/upper Sacramento River transition zone. Additionally, three populations were found along the Sacramento Arm near Elmore Mountain during surveys conducted in 2010 (Figure 12-5c).

Shasta snow-wreath is currently known from 24 locations, most of which occur at or near the periphery of Shasta Lake. Ten Shasta snow-wreath populations occur in habitats associated with limestone formations, and 13 occur in other habitat types. Most populations are associated with stream drainages or the lower portions of upland slopes. Of these, 13 Shasta snow-wreath populations were discovered during the botanical surveys along the McCloud Arm (south of Shasta Caverns and Keluche Creek), Pit Arm (Brock Creek, Ripgut Creek, Flat Creek, Stein Creek, and west of Stein Creek), and the Main Body (Blue Ridge east, Blue Ridge west, Blue Ridge middle, Cove Creek, south of Cove Creek, and Jones Valley). Locations of Shasta snow-wreath found incidentally and during the surveys are shown in Figures 12-5a through 12-3f.

Slender false lupine populations were discovered in all portions of the primary study area, generally on low-gradient slopes. Locations of slender false lupine found during the surveys and incidentally are shown in Figures 12-5a through 12-5f.

Shasta huckleberry is currently known from 23 occurrences at 13 general locations. Shasta huckleberry occurs at four locations in the project area: (little) Squaw Creek, Shoemaker Gulch, Little Backbone Creek, and Horse Creek near Bully Hill. The Shasta huckleberry populations at these locations represent the lower portions of larger populations of hundreds to over a thousand shrubs that extend further upstream in and around each stream. All locations occur in an area historically known as the Copper Belt of Shasta County and occur in the vicinity of historic copper mining activities. Locations of Shasta huckleberry in the project area found during the surveys are shown in Figures 12-5a through 12-5f. Two oval-leaved viburnum populations were found during the surveys. One population was found in a forested upland slope west of Pine Point Campground along the McCloud Arm and a second in chaparral habitat in Jones Valley along the Pit Arm near the Clikapudi Trail. Locations of oval-leaved viburnum found during the surveys are shown in Figures 12-5d and 12-5f.

Three Shasta limestone monkeyflower occurrences were found in the impoundment area. These occurrences are in the McCloud Arm and include populations downslope from Samwell Cave, at Dekkas Rock, and in the Campbell Creek inlet. The Samwell Cave and Dekkas Rock populations extend upslope and above the impoundment areas, while the population at Campbell Creek occurs entirely within the impoundment area. Nineteen additional Shasta limestone monkeyflower occurrences were found in locations outside the project area. Locations of Shasta limestone monkeyflower found during the surveys are shown in Figures 12-5d and 12-5f.

Reclamation conducted biological resource assessments at each of the six potential Sacramento River downstream habitat restoration areas during 2013. The assessments include botanical surveys for special-status plants and noxious weeds. No special-status plants were found during these surveys. The biological resource assessment results are included as Attachments 12 through 23 to the Botanical Resources and Wetlands Technical Report.

This page left blank intentionally.

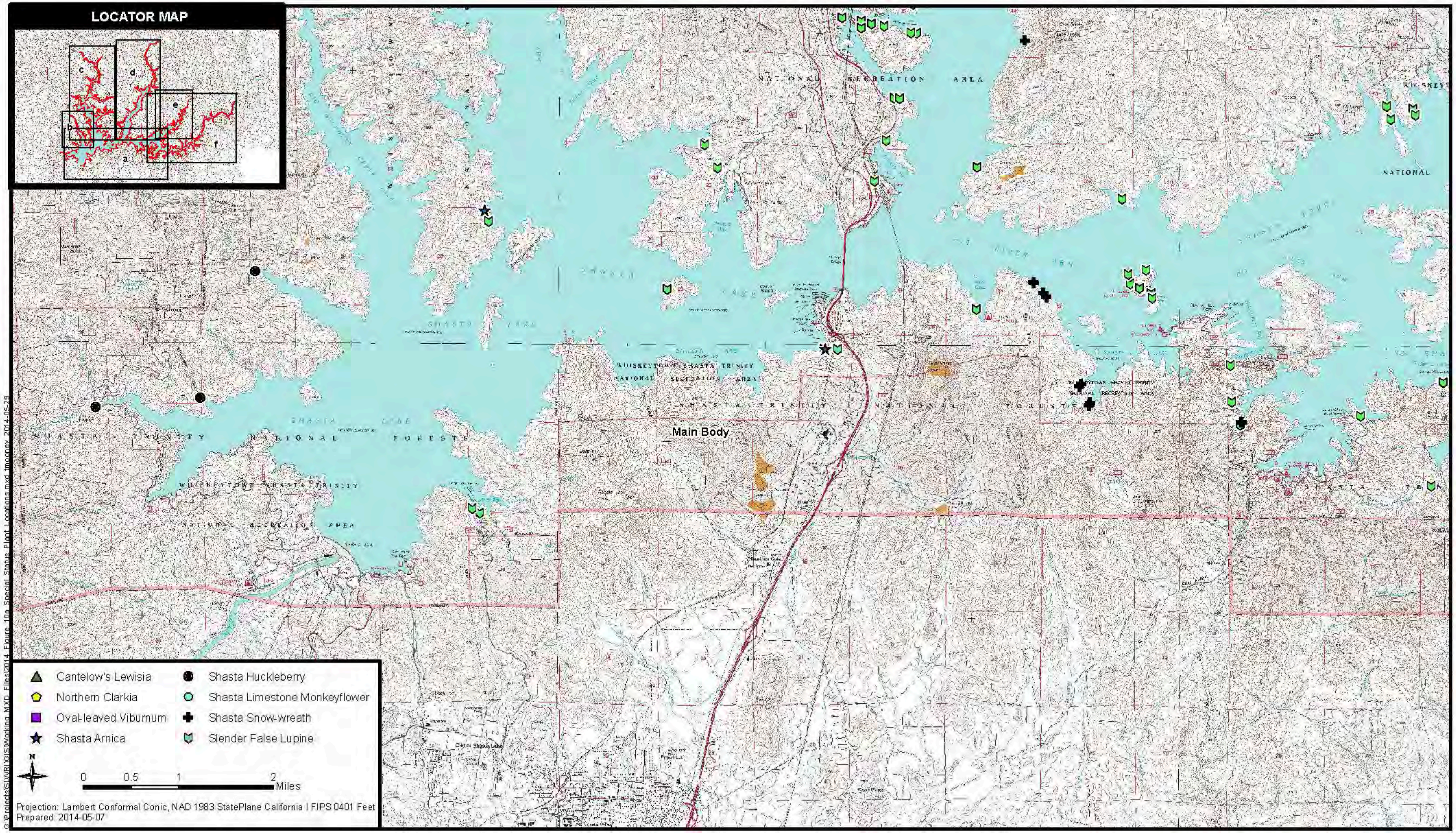
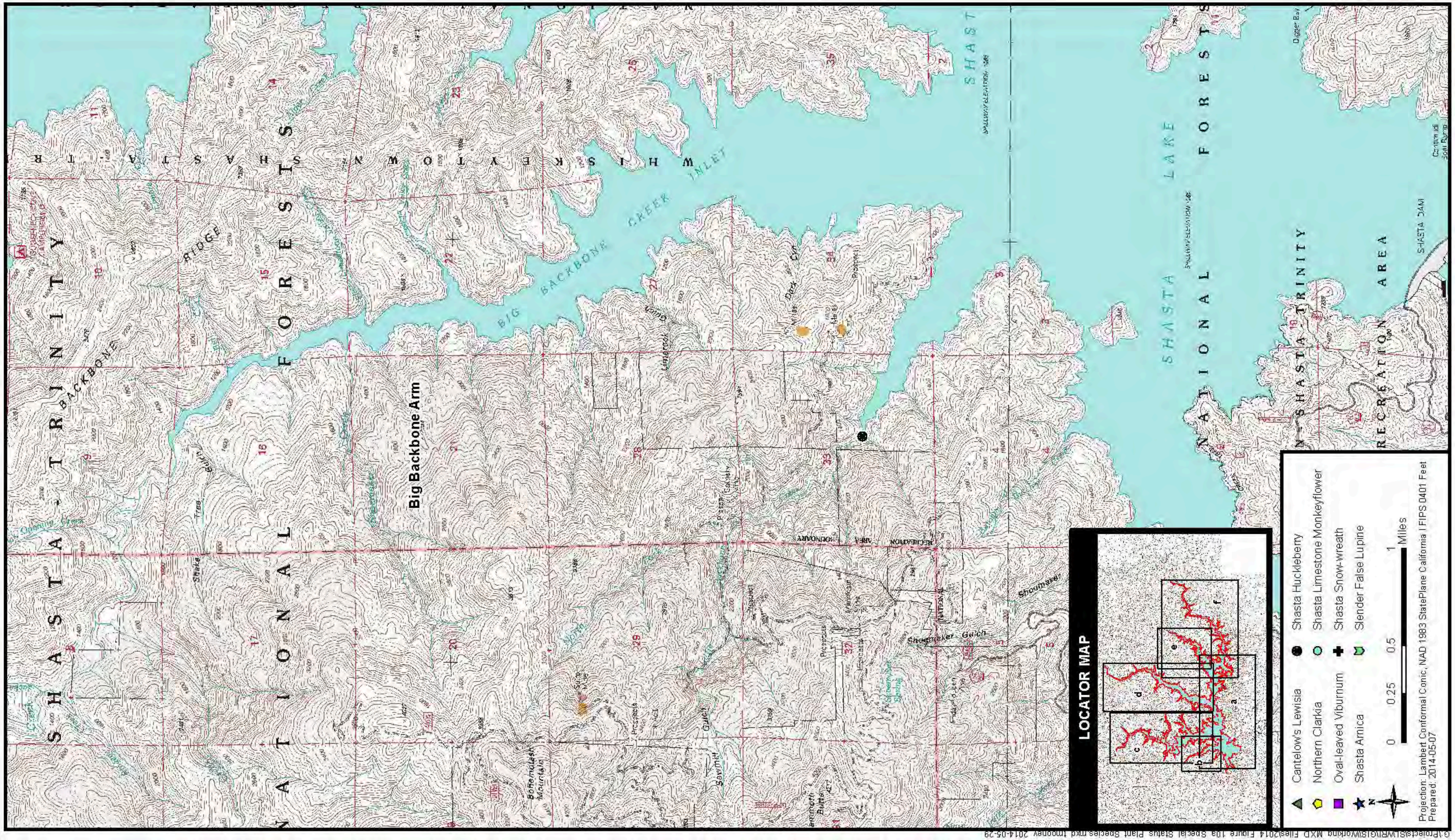
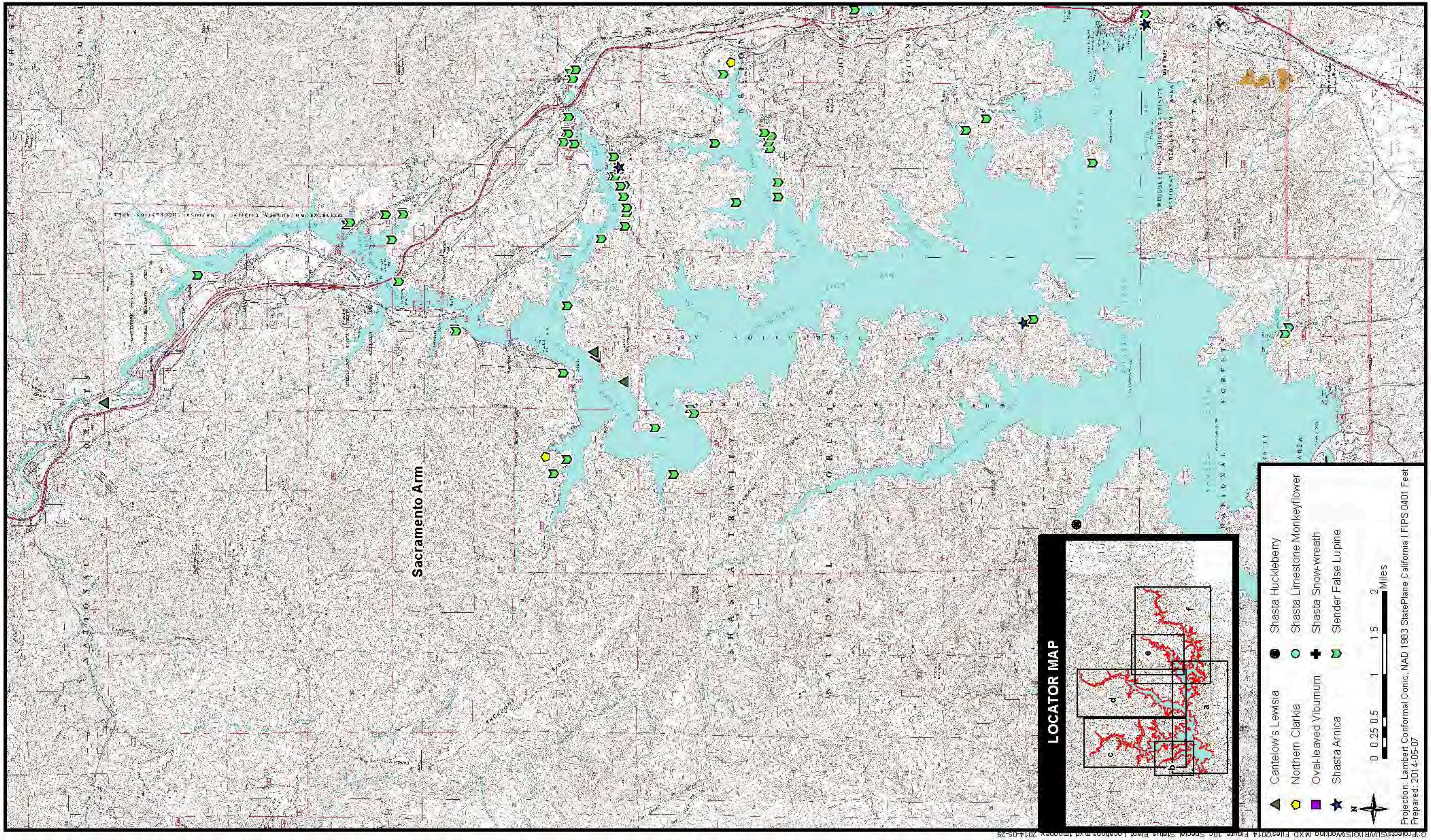


Figure 12-5a. Special-Status Plant Species Occurring in Shasta Lake and Vicinity

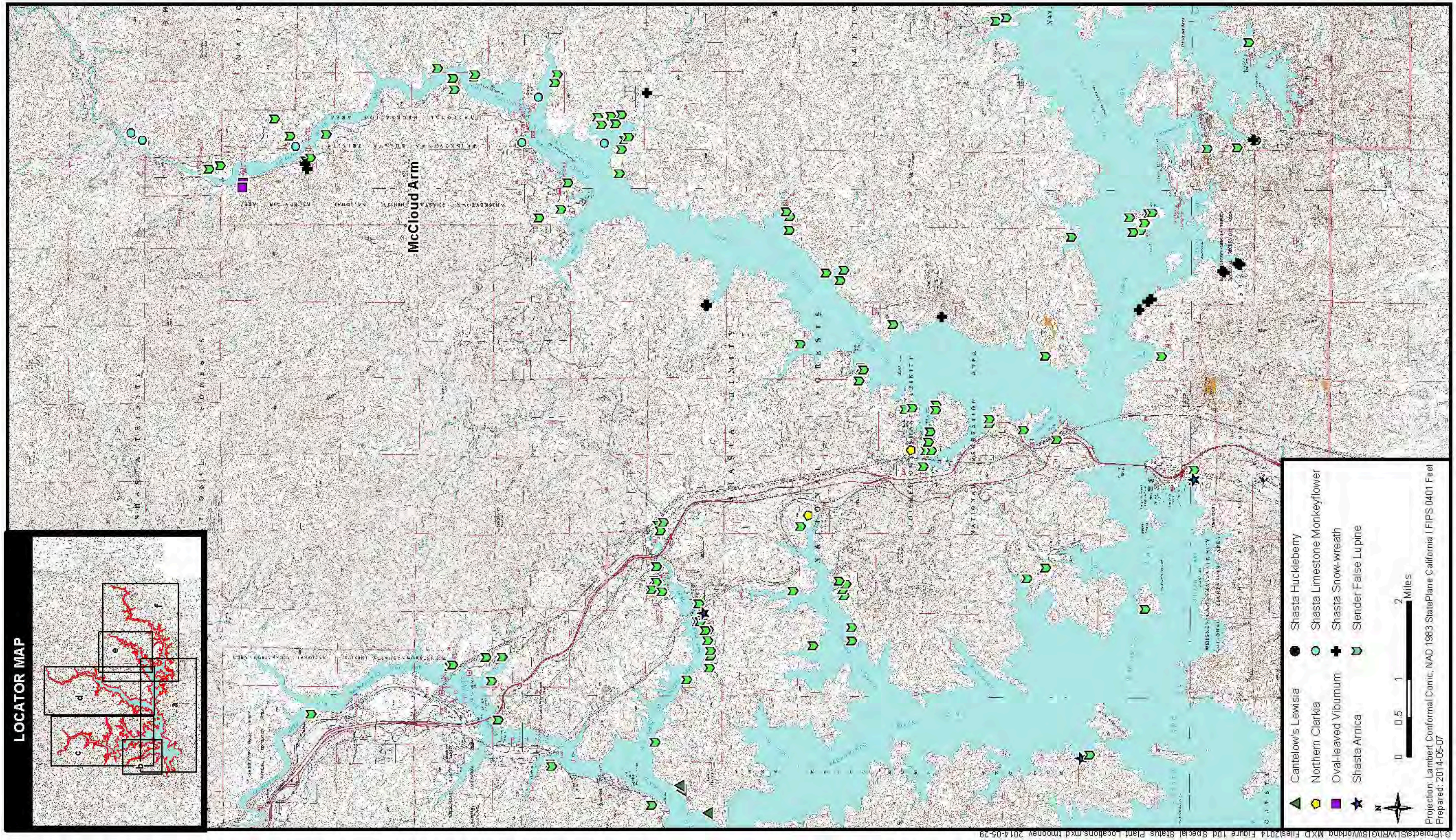
This page left blank intentionally.


Big Backbone Arm
SHASTA - TRINITY NATIONAL FOREST
SHASTA LAKE
SHASTA - TRINITY NATIONAL FOREST
SHASTA TRINITY
RECREATION AREA
WHISKEYTOWN - SHASTA - TRINITY
BIG BACKBONE CREEK INLET
BACKBONE RIDGE
SHASTA DAM
Shoemaker Gulch
LOCATOR MAP
a
b
c
d
e
f
Cantelow's Lewisia
Northern Clarkia
Oval-leaved Viburnum
Shasta Arnica
Shasta Huckleberry
Shasta Limestone Monkeyflower
Shasta Snow-wreath
Slender False Lupine
0
0.25
0.5
1
Miles
Projection: Lambert Conformal Conic, NAD 1983 StatePlane California I FIPS 0401 Feet
Prepared: 2014-05-07

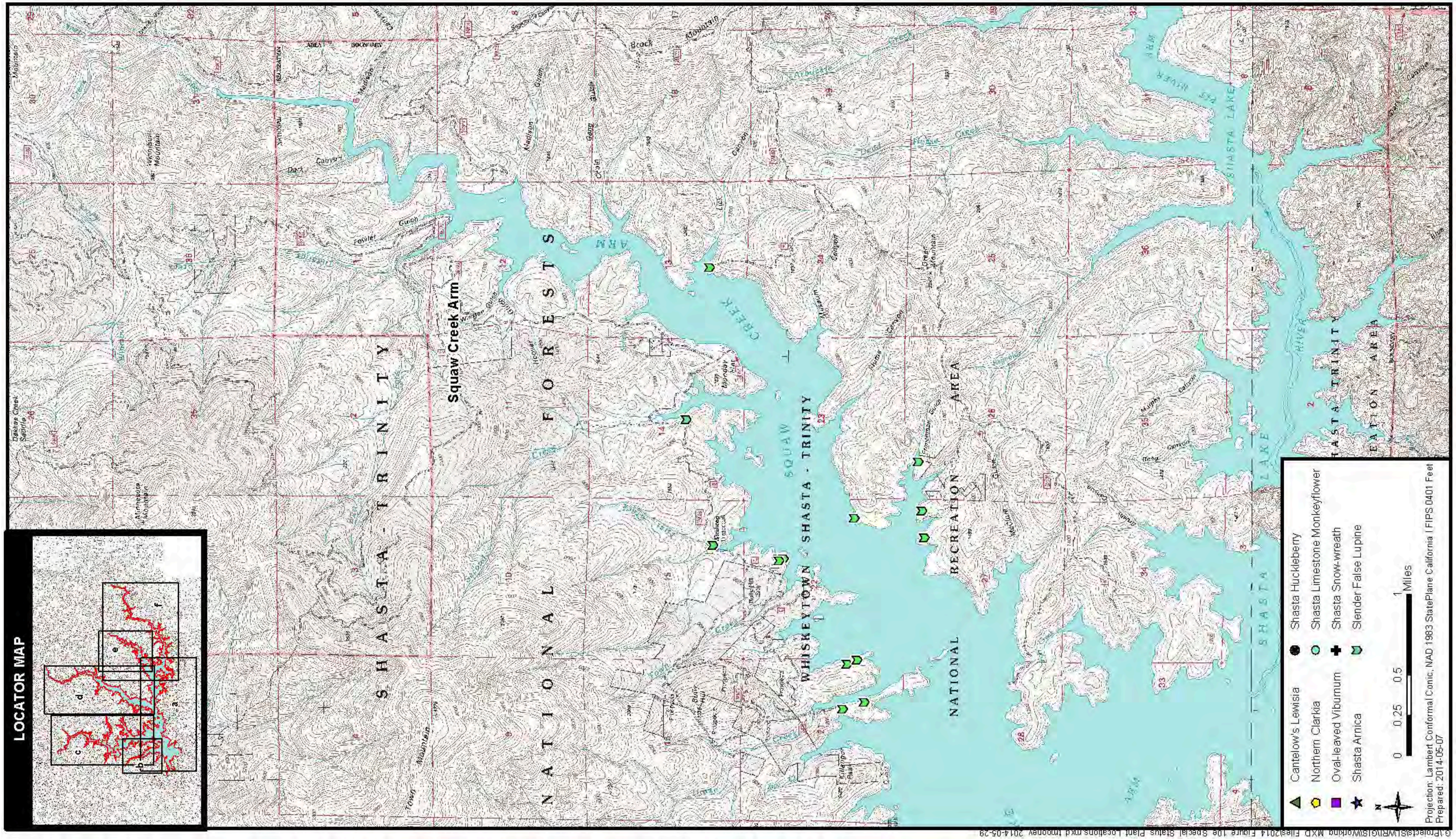
This page left blank intentionally.


Sacramento Arm
LOCATOR MAP
Cantelow's Lewisia
Northern Clarkia
Oval-leaved Viburnum
Shasta Arnica
Shasta Huckleberry
Shasta Limestone Monkeyflower
Shasta Snow-wreath
Slender False Lupine
0 0.25 0.5 1 1.5 2 Miles
Projection: Lambert Conformal Conic, NAD 1983 StatePlane California I FIPS 0401 Feet
Prepared: 2014-05-07

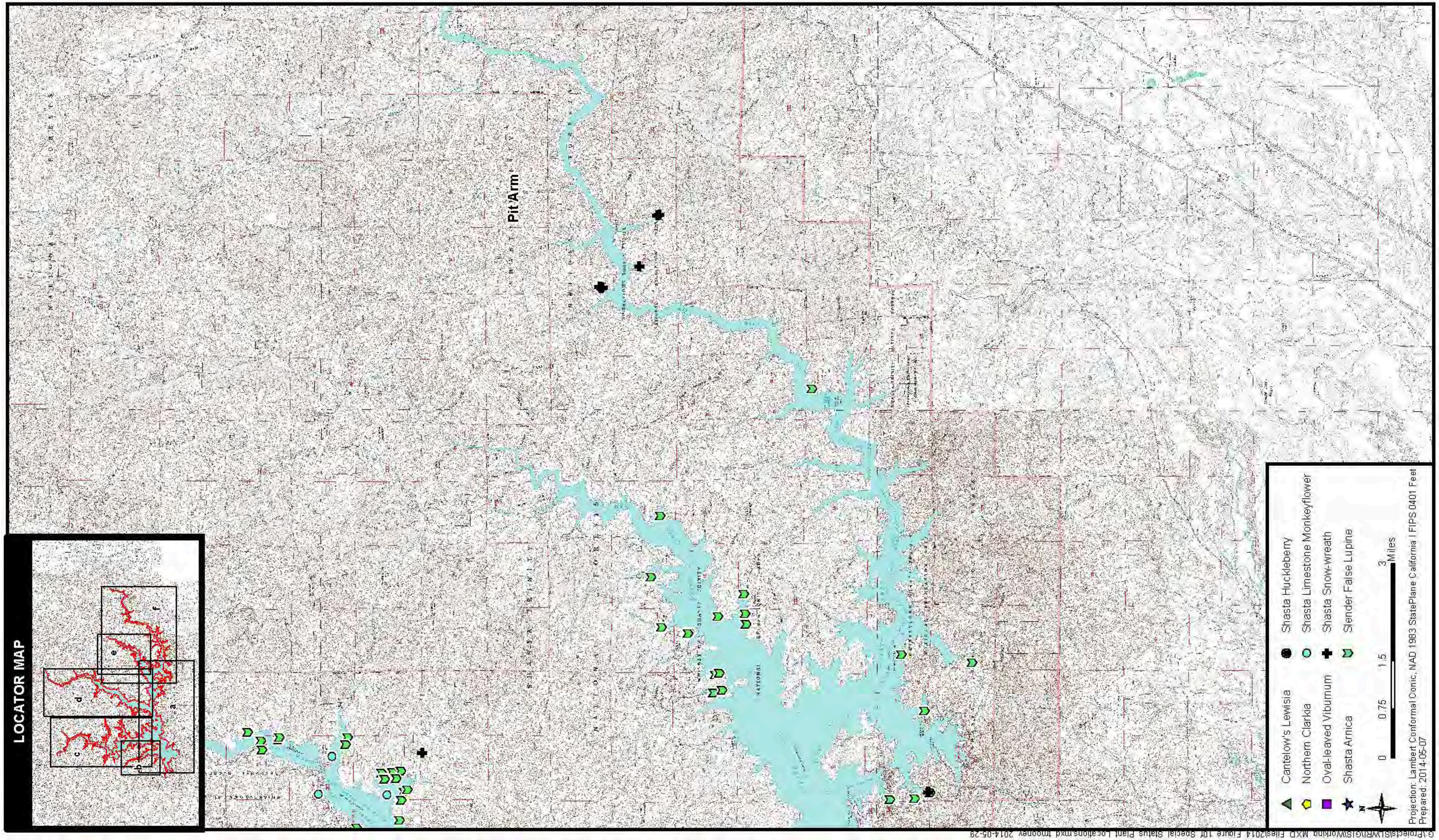
This page left blank intentionally.


LOCATOR MAP
McCloud Arm
Cantelow's Lewisia
Northern Clarkia
Oval-leaved Viburnum
Shasta Arnica
Shasta Huckleberry
Shasta Limestone Monkeyflower
Shasta Snow-wreath
Slender False Lupine
0
0.5
1
2
Miles
Projection: Lambert Conformal Conic, NAD 1983 StatePlane California I FIPS 0401 Feet
Prepared: 2014-05-07

This page left blank intentionally.


Squaw Creek Arm
LOCATOR MAP
Cantelow's Lewisia
Northern Clarkia
Oval-leaved Viburnum
Shasta Arnica
Shasta Huckleberry
Shasta Limestone Monkeyflower
Shasta Snow-wreath
Slender False Lupine
0 0.25 0.5 1 Miles
Projection: Lambert Conformal Conic, NAD 1983 StatePlane California I FIPS 0401 Feet
Prepared: 2014-05-07
SHASTA - TRINITY NATIONAL FOREST
WHISKEYTOWN - SHASTA - TRINITY NATIONAL RECREATION AREA
SQUAW CREEK ARM
SHASTA LAKE

This page left blank intentionally.


Pit Arm
LOCATOR MAP
a
b
c
d
e
f
Cantelow's Lewisia
Northern Clarkia
Oval-leaved Viburnum
Shasta Arnica
Shasta Huckleberry
Shasta Limestone Monkeyflower
Shasta Snow-wreath
Slender False Lupine
0
0.75
1.5
3
Miles
N
Projection: Lambert Conformal Conic, NAD 1983 StatePlane California I FIPS 0401 Feet
Prepared: 2014-05-07

This page left blank intentionally.

Upper Sacramento River (Shasta Dam to Red Bluff)

Based on review of CNDDB and CNPS database searches, a USFWS list of species that could be potentially affected in this portion of the primary study area, and previously prepared biological reports for the area, 25 special-status plant species were identified as possibly occurring in the primary study area between Shasta Dam and RBPP, and thus their potential to occur in this portion of the study area was evaluated further. These special-status plant species, along with the legal status, habitat, and potential for occurrence of each species, are provided in Table 12-6.

Sixteen of the special-status plant species listed in Table 12-6 have the potential to occur within habitat present along the Sacramento River between Shasta Dam and RBPP. Many of these species, such as Bogg's Lake hedge hyssop (*Gratiola heterosepala*; State endangered, MSCS m, CRPR 1B.2), Ahart's dwarf rush (*Juncus leiospermus* var. *ahartii*; MSCS m, CRPR 1B.2), Ahart's paronychia (*Paronychia ahartii*; MSCS m, CRPR 1B.1), dwarf downingia (*Downingia pusilla*; CRPR 2B.2), Greene's legenere (*Legenere limosa*; MSCS m, CRPR 1B.1), Henderson's bent grass (*Agrostis hendersonii*; MSCS m, CRPR 3.2), Red Bluff dwarf rush (*Juncus leiospermus* var. *leiospermus*; CRPR 1B.2), and slender Orcutt grass (*Orcuttia tenuis*; Federal endangered, state endangered, MSCS m, CRPR 1B.1), typically occur in vernal pools, which are generally not present within the active floodplain of regulated rivers in the extended study area. Other special-status plants, however, could occur in the extended study area in the freshwater marshes, swamps, and riparian woodlands that are found along the river corridor. These species include rose mallow (*Hibiscus lasiocarpus* var. *occidentalis*; MSCS m, CRPR 2B.2) and silky cryptantha (*Cryptantha crinita*; USFS SM, CRPR 1B.2). The remaining five species may occur in annual grassland, chaparral, cismontane woodland, and lower montane coniferous forest vegetation communities along the river corridor, including adobe-lily (*Fritillaria pluriflora*; MSCS m, CRPR 1B.2), Butte County fritillary (*Fritillaria eastwoodiae*; USFS S, CRPR 3.2), dubious pea (*Lathyrus sulphureus* var. *agillaceous*; CRPR 3), mountain lady's slipper (*Cypripedium fasciculatum*; USFS SM, CRPR 4.2), and oval-leaved viburnum (*Viburnum ellipticum*; CRPR 2B.3).

Of the special-status species that could occur along the upper Sacramento River, four are known to occur along the edge of the Sacramento River channel, or along a Sacramento River tributary within 0.2 mile of the river proper, and their establishment and reproduction could potentially be affected by changes in flow regime: silky cryptantha, rose mallow, and Ahart's paronychia (CNDDB 2007, University of California 2011).

Table 12-6. Special-Status Plant Species Known or with Potential to Occur in the Primary Study Area, Along the Sacramento River from Shasta Dam to Red Bluff Pumping Plant

Species	Legal Status[1]					Habitat and Blooming Period	Potential for Occurrence
	USFWS	CDFW	MSCS	USFS	CRPR		
Shasta ageratina *Ageratina shastensis*		–		E	1B.2	Rocky carbonate outcrops in chaparral and lower montane coniferous forest; 1,300–5,900 feet elevation. Blooms June–October.	Could occur near Shasta Dam if suitable outcrops are present. Potential is low because most of the primary study area is below species' known elevation range.
Henderson's bent grass *Agrostis hendersonii*	–	–	m	–	3.2	Mesic sites in valley and foothill grassland, vernal pools; 230–1,000 feet elevation. Blooms April–May.	Could occur along the Sacramento River if suitable vernally mesic habitat is present.
Shasta County arnica *Arnica venosa*	–	–	–	E	4.2	Cismontane woodlands and lower montane coniferous forests, often in disturbed areas and roadcuts; 1,300–4,900 feet elevation. Blooms May–July.	Could occur along the Sacramento River and tributaries within the primary study area. Potential is low because most of the study area is below species' known elevation range.
Sulphur Creek Brodiaea *Brodiaea matsonii*	–	–	–	–	1B.1	Rocky, metamorphic amphibolite schist. Cismontane woodland (streambanks), meadows, and seeps; 640-700 feet elevation. Blooms May–June.	Could occur along the Sacramento River and tributaries within the primary study area.
Silky cryptantha *Cryptantha crinita*	–	–	m	–	1B.2	Gravelly streambeds within cismontane woodland, lower montane coniferous forest, riparian forest, riparian woodland, valley and foothill grassland; 275–4,000 feet elevation. Blooms April–May.	Could occur along the Sacramento River and tributaries within the primary study area.
Clustered lady's slipper *Cypripedium fasciculatum*	–	–	–	SM	4.2	Lower montane coniferous forest, North Coast coniferous forest; often in serpentinite seeps or on streambanks; 300–8,000 feet elevation. Blooms March–July.	Unlikely; no coniferous forest known in the primary study area.

Table 12-6. Special-Status Plant Species Known or with Potential to Occur in the Primary Study Area, Along the Sacramento River from Shasta Dam to Red Bluff Pumping Plant (contd.)

Species	Legal Status[1]					Habitat and Blooming Period	Potential for Occurrence
	USFWS	CDFW	MSCS	USFS	CRPR		
Mountain lady's slipper *Cypripedium montanum*	–	–	–	SM	4.2	Broadleaved upland forest, cismontane woodland, lower montane coniferous forest, North Coast coniferous forest; 500–7,000 feet elevation. Blooms March–July.	Could occur at Shasta Dam or along the Sacramento River and tributaries.
Dwarf downingia *Downingia pusilla*	–	–	–	–	2.2	Mesic sites in valley and foothill grassland, vernal pools. Blooms March–May.	Could occur along the Sacramento River if suitable vernally mesic habitat is present.
Butte County fritillary *Fritillaria eastwoodiae*	–	–	–	S	3.2	Openings and sometime serpentine areas in chaparral, cismontane woodland, and lower montane coniferous forest; 160–4,900 feet elevation. Blooms March–June.	Could occur along the Sacramento River and tributaries within the primary study area.
Adobe-lily *Fritillaria pluriflora*	–	–	m	–	1B.2	Chaparral, cismontane woodland, valley and foothill grassland; often in adobe soils; 200–2,300 feet elevation. Blooms February–April.	Could occur at Shasta Dam and along the Sacramento River.
Bogg's Lake hedge hyssop *Gratiola heterosepala*	–	E	m	–	1B.2	Marshes and swamps, vernal pools; 30–8,000 feet elevation. Blooms April–August.	Could occur along the Sacramento River and tributaries.
Rose mallow *Hibiscus lasiocarpus* var. *occidentalis*	–	–	m	–	1B.2	Freshwater marshes and swamps.	Could occur along the Sacramento River and tributaries.
Ahart's dwarf rush *Juncus leiospermus* var. *ahartii*	–	–	m	–	1B.2	Mesic sites in valley and foothill grassland; 100–300 feet elevation. Blooms March–May.	Could occur along the Sacramento River if suitable vernally mesic habitat is present. Shasta Dam is higher than species' known elevation range.
Red Bluff dwarf rush *Juncus leiospermus* var. *leiospermus*	–	–	–	–	1B.1	Vernally mesic sites in chaparral, cismontane woodland, meadows and seeps, valley and foothill grassland, vernal pools; 100–3,350 feet elevation. Blooms March–May.	Could occur at Shasta Dam or along the Sacramento River if suitable vernally mesic habitat is present.

Table 12-6. Special-Status Plant Species Known or with Potential to Occur in the Primary Study Area, Along the Sacramento River from Shasta Dam to Red Bluff Pumping Plant (contd.)

Species	Legal Status[1]					Habitat and Blooming Period	Potential for Occurrence
	USFWS	CDFW	MSCS	USFS	CRPR		
Dubious pea *Lathyrus sulphureus* var. *argillaceous*	–	–	–	–	3	Cismontane woodland, lower montane coniferous forest, upper montane coniferous forest; 500–1,000 feet elevation. Blooms in April.	Could occur at Shasta Dam and along the Sacramento River.
Greene's legenere *Legenere limosa*	–	–	m	–	1B.1	Vernal pools; 1–3,000 feet elevation. Blooms April–June.	Could occur along Sacramento River if suitable vernal pool habitat is present.
Cantelow's lewisia *Lewisia cantelovii*	–	–	–	S	1B.2	Mesic granitic sites within broadleaved upland forest, chaparral, cismontane woodland, and lower montane coniferous forest; 1,250–4,500 feet. Sometimes in serpentinite seeps. Blooms May–October.	Could occur in the Shasta Dam area. The remainder of the primary study area is below species' known elevation range.
Bellinger's meadowfoam *Limnanthes floccosa* ssp. *bellingeriana*	–	–	m	–	1B.2	Mesic sites in cismontane woodland, meadows and seeps; 950–3,600 feet elevation. Blooms April–June.	Could occur at Shasta Dam. Potential along Sacramento River is low because majority of the primary study area is below species known elevation range.
Shasta snow-wreath *Neviusia cliftonii*	–	–	m	S	1B.2	Carbonate substrates in lower montane coniferous forest and riparian woodland; 1,000–1,600 feet elevation. Blooms May–June.	Could occur in Shasta Dam area. Unlikely to occur along Sacramento River because the primary study area is lower than species known elevation range.
Slender orcutt grass *Orcuttia tenuis*	E	E	m	–	1B.1	Vernal pools; 100–6,000 feet elevation. Blooms May–October.	Could occur along the Sacramento River if suitable vernal pool habitat is present. Federally designated critical habitat for this species occurs east of the Sacramento River, east of Cottonwood (Units 3A and 3B) and northeast of Anderson (Units 2C and 2D).

Table 12-6. Special-Status Plant Species Known or with Potential to Occur in the Primary Study Area, Along the Sacramento River from Shasta Dam to Red Bluff Pumping Plant (contd.)

Species	Legal Status[1]					Habitat and Blooming Period	Potential for Occurrence
	USFWS	CDFW	MSCS	USFS	CRPR		
Ahart's paronychia *Paronychia ahartii*	–	–	m	–	1B.1	Cismontane woodland, valley and foothill grassland, vernal pools; 100–1,700 feet elevation. Blooms March–June.	Could occur at Shasta Dam and along the Sacramento River.
Pacific fuzzwort *Ptilidium californicum*	–	–	–	SM	4.3	An epiphytic on bark at the base of standing mature to old-growth trees or recently fallen logs; rarely on other organic substrates such as decaying logs and stumps, or humus covering boulders; 1,275–5,725 feet elevation.	Could occur along the Sacramento River and tributaries within the primary study area. Potential is low because most of the study area is below species' known elevation range.
Canyon Creek stonecrop *Sedum obtusatum* ssp. *paradisum*	–	–	–	S	1B.3	Granitic, rocky areas in broadleafed upland forest, chaparral, lower montane coniferous forest, subalpine coniferous forest; 980–6,100 feet elevation. Blooms May–June.	Could occur along the Sacramento River and tributaries within the primary study area. Potential is low because most of the study area is below species' known elevation range.
English Peak greenbriar *Smilax jamesii*	–	–	m	-	1B.3	Found along streambanks and lake margins in broadleafed upland forest, lower montane, upper montane, and north coast coniferous forests, and marshes and swamps; 1,600–8,200 feet elevation. Blooms May–July, rarely through August.	Could occur along the Sacramento River and tributaries within the primary study area. Potential is low because most of the study area is below species' known elevation range.
Oval-leaved viburnum *Viburnum ellipticum*	–	–	–	–	2.3	Chaparral, cismontane woodland, lower montane coniferous forest; 800–4,600 feet elevation. Blooms May–June.	Could occur at Shasta Dam and along the Sacramento River.

Sources: CNDDB 2007, CNPS 2011, USFS 2007, USFWS 2011

Note: [1]Legal Status

U.S. Fish and Wildlife Service (USFWS) Federal Listing Categories:
T = Threatened
E = Endangered

U.S. Forest Service (USFS) Listing Categories:
E = Endemic to specific region or National Forest
S = Sensitive
SM = Species considered rare or threatened and recommended for survey and management per Northwest Forest Plan 2002

California Department of Fish and Wildlife (CDFW) State Listing Categories:
R = California Rare
T = California Threatened
E = California Endangered

California Rare Plant Rank (CRPR) Categories:
1B = Plants rare, threatened, or endangered in California and elsewhere
2A, 2B = Plants rare, threatened, or endangered in California but more common elsewhere
3 = Plants for which more information is needed—a review list
4 = Plants of limited distribution—a watch list

Multi-Species Conservation Strategy (MSCS) Listing Categories:
R = recovery r = contribute to recovery m = maintain

Lower Sacramento River and Delta

Most of the special-status plant species listed in Table 12-6 have the potential to occur within the extended study area (lower Sacramento River and Delta and CVP/SWP service areas). Numerous additional special-status plant species could occur in the extended study area. Attachment 4 of the *Botanical Resources and Wetlands Technical Report* contains comprehensive lists of all sensitive plant species in the extended study area that have been reported to the CNDDB, or that otherwise have the potential to occur in the extended study area.

A number of special-status plant species could be affected in the lower Sacramento River and Delta by changes in hydrology (CALFED 2000c). These include species associated with vernal pool, riparian, marsh, and aquatic plant communities; and several other species with restricted distributions on or near channel banks, active floodplains, flood bypasses, and Delta waterways. These assemblages of special-status species are described below.

Species of Vernal Pool Communities In addition to species that are potentially present in the primary study area (Table 12-6), special-status plant species that may be associated with vernal pools along the lower Sacramento River and in the Delta region include alkali milk-vetch (*Astragalus tener* var. *tener*; MSCS r, CRPR 1B.2), brittlescale (*Atriplex depressa*; MSCS m, CRPR 1B.2), Hoover's spurge (*Euphorbia hooveri*; Federal threatened, MSCS m, CRPR 1B.2), Contra Costa goldfields (*Lasthenia conjugens*; Federal endangered, MSCS m, CRPR 1B.1), hairy orcutt grass (*Orcuttia pilosa*; Federal endangered, MSCS m, CRPR 1B.1), slender Orcutt grass (*Orcuttia tenuis*; Federal threatened, MSCS m, CRPR 1B.1), bearded popcornflower (*Plagiobothrys hystriculus*; CRPR 1B.1), Delta woolly-marbles (*Psilocarphus brevissimus* var. *multiflorus*; CRPR 4.2), Crampton's tuctoria (*Tuctoria mucronata*; Federal and State endangered, MSCS r, CRPR 1B.1), and Greene's tuctoria (*Tuctoria greenei*; Federal endangered, MSCS m, CRPR 1B.1). The primary threats affecting most of these species at multiple locations are habitat loss because of development, nonnative species, and incompatible grazing practices. Additional threats affecting some of these species at one or more location include game management practices (e.g., inundation of land for waterfowl during the growing season), off-road vehicle use and trampling, incompatible agricultural practices, and hydrological alterations.

Species of Riparian and Marsh Communities In addition to species considered potentially present in the primary study area (Table 12-6), special-status plant species associated with riparian and marsh communities along the lower Sacramento River or in the Delta region include bristly sedge (*Carex comosa*; MSCS r, CRPR 2B.1), Suisun thistle (*Cirsium hydrophilum* var. *hydrophilum*; Federal endangered, MSCS R, CRPR 1B.1), Soft bird's-beak (*Chloropyron molle* ssp. *molle*; Federal endangered, State rare, MSCS R, CRPR 1B.2), Delta button-celery (*Eryngium racemosum*; MSCS r, CRPR 1B.1), Northern California black walnut (*Juglans hindsii*; MSCS r, CRPR 1B.1), Delta tule pea (*Lathyrus jepsonii* var. *jepsonii*; MSCS r, CRPR 1B.2), Mason's lilaeopsis (*Lilaeopsis masonii*; MSCS R, CRPR 1B.1), Delta mudwort (*Limosella australis*; MSCS r, CRPR 2B.1), Sanford's arrowhead (*Sagittaria sanfordii*; MSCS m, CRPR 1B.2), Marsh skullcap (*Scutellaria galericulata*; MSCS m, CRPR 2B.2), blue skullcap (*Scutellaria lateriflora*; MSCS m, CRPR 2B.2), and Suisun Marsh aster (*Symphyotrichum lentum*; CRPR 1B.2) (CNDDB 2007, CRPR 2011). The primary threats affecting these species are habitat loss, competition from nonnative species, and alterations to hydrology (including trenching and diking). Additional threats include grazing and trampling, installation of riprap, and anthropogenic disturbances (e.g., off-road vehicles; road, utility, and levee maintenance).

Species of Aquatic Communities Eel-grass pondweed (*Potamogeton zosteriformis*; MSCS m, CRPR 2B.2), a submerged aquatic plant of assorted freshwater habitats, is rare in California but more common elsewhere (CNPS 2011). Overall, the distribution, abundance, and threats affecting this species in California are not well known.

CVP/SWP Service Areas

Special-status plants are not likely to occur in a substantial portion of the CVP and SWP service areas because the agricultural and urban land uses tend to preclude suitable habitat for most native species. Although agricultural and developed land uses account for most of the CVP and SWP service areas, a portion of these areas still remains in natural vegetation, Because of the large size of the CVP and SWP service areas, this natural vegetation is distributed over a wide range of climate and soils, and is varied in structure and species composition. Consequently, a large number of special-status plant species has the potential to occur in the natural vegetation that remains within the CVP and SWP service areas (see the *Botanical Resources and Wetlands Technical Report*).

12.1.3 Invasive Species

Shasta Lake and Vicinity and Potential Sacramento River Downstream Restoration Sites

Nonnative plant species introduced to the region are of concern in the Shasta Lake and vicinity portion of the primary study area. When plants that evolved in one region of the globe are moved by humans to another region, a few flourish, crowding out native vegetation and wildlife that feed on the native species. Some invasive plants can even change ecosystem processes such as hydrology, fire regimes, and soil chemistry. These invasive plants have a competitive advantage because they are no longer controlled by their natural predators and can quickly spread. In California, approximately 3 percent of the plant species growing in the wild are considered invasive, but they inhabit a much greater proportion of the landscape (Cal-IPC 2007).

Plant pests are defined by law, regulation, policy, and technical organizations, and are regulated by many different bodies, including the California Department of Food and Agriculture (CDFA), U.S. Department of Agriculture, and the California Invasive Plant Council (Cal-IPC). The CDFA uses an action-oriented pest-rating system. The low rating assigned to a pest by CDFA does not necessarily mean that the pest is not a problem; rather, the rating system is meant to prioritize response by CDFA and county agricultural commissioners. Plants on CDFA's highest priority "A" list are defined as plants "of known economic importance subject to state-county enforced action involving eradication, quarantine regulation, containment, rejection or other holding action." Cal-IPC has developed a list of plant pests specific to California wildlands. The Cal-IPC list is based on information submitted by land managers, botanists, and researchers throughout the state and on published sources. To determine plant pests potentially occurring in the Shasta Lake and vicinity portion of the primary study area, this list was reviewed and local agencies (BLM, USFS, California Department of Transportation, and Shasta County Department of Agriculture) were contacted to gather information about known weed locations (Table 12-7). Additional information about noxious weeds has been compiled by Reclamation from observations made during botanical and other technical studies. Attachment 5 describes each weed source location, the potential mode of spread, and the risk of spread at each of the known sites.

Management actions have been required to prevent the loss of habitat caused by some of the more invasive exotic species that out-compete native vegetation. However, these management actions have been limited and have been confined primarily to areas adjacent to campgrounds and USFS facilities.

Table 12-7. Nonnative Plant Species Known to Occur in the Shasta Lake and Vicinity Portion of the Primary Study Area

Common Name	Scientific Name	Cal-IPC Rating[1]	CDFA Rating[2]	Habitat
Silver wattle	*Acacia dealbata*	Moderate	None	Mixed woodlands, riparian
Barbed goatgrass	*Aegilops triuncialis*	High	B	Grassland, rangeland, oak woodland
Tree of heaven	*Ailanthus altissima*	Moderate	None	Grassland, oak woodland, riparian
Broomsedge	*Andropogon virginicus*	None	None	Riparian, disturbed areas
Giant reed	*Arundo donax*	High	None	Riparian
Slender wild oats	*Avena barbata*	Moderate	None	Coastal scrub, grassland, oak woodland, forest
Common wild oats	*Avena fatua*	Moderate	None	Coastal scrub, grassland, oak woodland, forest
Black mustard	*Brassica nigra*	Moderate	None	Disturbed areas, fields

Table 12-7. Nonnative Plant Species Known to Occur in the Shasta Lake and Vicinity Portion of the Primary Study Area (contd.)

Common Name	Scientific Name	Cal-IPC Rating[1]	CDFA Rating[2]	Habitat
Rattlesnake grass	*Briza maxima*	Limited	None	Grassland
Ripgut brome	*Bromus diandrus*	Moderate	None	Dunes, scrub, grassland, woodland, forest
Soft brome	*Bromus hordeaceus*	Limited	None	Grassland, sage brush, serpentine soils
Red brome	*Bromus madritensis* ssp. *rubens*	High	None	Interior scrub, woodlands, grassland
Cheatgrass	*Bromus tectorum*	High	None	Interior scrub, woodlands, grassland
Lenspod whitetip	*Cardaria chalapensis*	Moderate-ALERT	B	Central Valley wetlands
Italian thistle	*Carduus pycnocephalus*	Moderate	None	Forest, scrub, grasslands, woodlands.
White knapweed	*Centaurea diffusa*	Moderate	A	Great basin scrub, coastal prairie
Spotted knapweed	*Centaurea maculosa*	High	A	Riparian, grassland, wet meadows, forests
Maltese star-thistle	*Centaurea melitensis*	Moderate	None	Disturbed areas, fields
Yellow star-thistle	*Centaurea solstitialis*	High	C	Grassland, woodlands, occasionally riparian
Squarrose knapweed	*Centaurea virgata* var. *squarrosa*	Moderate	A	Scrub, grassland, pinyon-juniper woodland
Rush skeleton weed	*Chondrilla juncea*	Moderate	A	Grassland
Canada thistle	*Cirsium arvense*	Moderate	B	Grassland, riparian areas, forests
Bull thistle	*Cirsium vulgare*	Moderate	None	Riparian areas, marshes, meadows
Poison hemlock	*Conium maculatum*	Moderate	None	Riparian areas
Field bindweed	*Convolvulus arvensis*	Evaluated, not listed	C	Agricultural weed
Pampas grass	*Cortaderia selloana*	High	None	Coastal, riparian
Bermuda grass	*Cynodon dactylon*	Moderate	C	Riparian scrub, common landscape weed
Gypsyflower	*Cynoglossum officinale*	Moderate	None	Disturbed areas
Hedgehog dogtailgrass	*Cynosurus echinatus*	Moderate	None	Grassland, oak woodland, disturbed areas
Scotch broom	*Cystis scoparius*	High	C	Coastal scrub, oak woodland
Orchardgrass	*Dactylis glomerata*	Limited	None	Grassland, disturbed areas

Table 12-7. Nonnative Plant Species Known to Occur in the Shasta Lake and Vicinity Portion of the Primary Study Area (contd.)

Common Name	Scientific Name	Cal-IPC Rating[1]	CDFA Rating[2]	Habitat
Fuller's teasel	*Dipsacus sativus*	Moderate	None	Fields, disturbed areas
Barnyardgrass	*Echinochloa crus-galli*	None	None	Wet, disturbed areas. fields
Medusa-head	*Elymus caput-medusae*	High	C	Grassland, scrub, woodland
Longbeak stork's bill	*Erodium botrys*	Evaluated, not listed	None	Many upland habitats
Redstem stork's bill	*Erodium cicutarium*	Limited	None	Many upland habitats
Leafy spurge	*Euphorbia esula*	High-ALERT	A	Forests, woodlands, juniper forests
Tall fescue	*Festuca arundinacea*	Moderate	None	Pasture
Rat-tail fescue	*Festuca myuros*	Moderate	None	Coastal sage scrub, chaparral
Italian ryegrass	*Lolium multiflorum*	Moderate	None	Grassland, oak woodlands, pinyon-juniper woodland
Fig	*Ficus carica*	Moderate	None	Riparian woodland
Fennel	*Foeniculum vulgare*	High	None	Grassland, scrub
French broom	*Genista monspessulana mospessulana*	High	C	Coastal scrub, oak woodland, grassland
Cutleaf geranium	*Geranium dissectum*	Limited	None	Grassland, disturbed areas
English ivy	*Hedera helix*	High	None	Coastal forest, riparian areas
Cutleaf geranium	*Geranium dissectum*	Limited	None	Grassland, disturbed areas
Mediterranean barley, foxtail	*Hordeum marinum, H. murinum*	Moderate	None	Grassland
Common St. John's wort	*Hypericum perforatum*	Moderate	C	Many habitats, disturbed
Rough cat's ear	*Hypochaeris radicata*	Moderate	None	Grassland, woodland
Pale yellow iris	*Iris pseudacorus*	Limited	None	Riparian, fresh emergent wetland
Dyer's woad, Marlahan mustard	*Isatis tinctoria*	Moderate	B	Great basin scrub and grassland
Dalmation toadflax	*Linaria dalmatica*	Moderate	A	Grassland, forest clearings
Italian ryegrass	*Lolium multiflorum*	Moderate	None	Grassland, oak woodlands, pinyon-juniper woodland
Perennial sweetpea	*Lathyrus latifolius*	None	None	Woodland, roadsides

Table 12-7. Nonnative Plant Species Known to Occur in the Shasta Lake and Vicinity Portion of the Primary Study Area (contd.)

Common Name	Scientific Name	Cal-IPC Rating[1]	CDFA Rating[2]	Habitat
Water primrose	*Ludwigia peploides*	High	None	Ponds, lakes
Hyssop loosestrife	*Lythrum hyssopifolia*	Limited	None	Marsh, pond
Horehound	*Marrubium vulgare*	Limited	None	Pasture, grassland
Burclover	*Medicago polymorpha*	Limited	None	Grassland, disturbed areas
Parrotfeather	*Myriophyllum aquaticum*	High	None	Ponds, lakes
Oleander	*Nerium oleander*	Evaluated, not listed	None	Riparian areas
Pokeweed	*Phytolacca americana*	None	None	Riparian forest, riparian woodland
Annual rabbitsfoot grass	*Polypogon monspeliensis*	Limited	None	Riparian areas
Wild radish	*Raphanus sativus*	Limited	None	Fields, disturbed areas
Black locust	*Robinia pseudoacacia*	Limited	None	Riparian areas, canyons
Himalayan blackberry	*Rubus armeniacus*	High	None	Riparian areas, marshes, oak woodlands
Cutleaf blackberry	*Rubus laciniatus*	None	None	Riparian areas, marshes, oak woodlands
Common sheep sorrel	*Rumex acetosella*	Moderate	None	Grassland, disturbed areas
Curly dock	*Rumex crispus*	Limited	None	Grassland, vernal pools, meadows, riparian
Bouncingbet	*Saponaria officinalis*	Limited	None	Oak woodland, streambed
Tansy ragwort	*Senecio jacobaea*	Limited	B	Grassland, riparian
Rattlebox	*Sesbania punicea*	High	None	Riparian
Johnsongrass	*Sorghum halepense*	None	C	Disturbed sites, moist places
Spanish broom	*Spartium junceum*	High	None	Coastal scrub, grassland, wetlands, oak woodland, forests
Medusa-head	*Taeniatherum caput-medusae*	High	C	Grassland, scrub, woodland
Spreading hedgeparsley	*Torilis arvensis*	Moderate	None	Grassland, woodland, disturbed areas
Puncturevine	*Tribulus terrestris*	None	C	Dry, disturbed areas
Rose clover	*Trifolium hirtum*	Limited	None	Grassland, woodland
Common mullein	*Verbascum thapsus*	Limited	None	Meadows, riparian, sagebrush, pinyon-juniper woodland
Periwinkle	*Vinca major*	Moderate	None	Riparian, oak woodlands, coastal scrub
Rat-tail fescue	*Vulpia myuros*	Moderate	None	Coastal sage scrub, chaparral

Table 12-7. Nonnative Plant Species Known to Occur in the Shasta Lake and Vicinity Portion of the Primary Study Area (contd.)

Notes:
[1] Cal-IPC Inventory Categories:

High	Severe ecological impacts on physical processes, plant and animal communities, and vegetation structure. Reproductive biology and other attributes are conducive to moderate to high rates of dispersal and establishment. Widely distributed ecologically.
Moderate	Substantial and apparent ecological impacts on physical processes, plant and animal communities, and vegetation structure. Reproductive biology and other attributes are conducive to moderate to high rates of dispersal, although generally dependent on ecological disturbance. Ecological amplitude and distribution may range from limited to widespread.
Limited	These species are invasive but their ecological impacts are minor on a statewide level or there was not enough information to justify a higher score. Their reproductive biology and other attributes result in low to moderate rates of invasiveness. Ecological amplitude and distribution are generally limited, but these species may be locally persistent and problematic (Cal-IPC 2012).

[2] CDFA Pest Ratings of Noxious Weed Species and Noxious Weed Seed

A – Eradication, containment, rejection, or other holding action at the state-county level.
B – Intensive control or eradication, where feasible, at the county level.
C – Control or eradication as local conditions warrant, at the county level.
Q – Rating as "A" is pending at the state or county level.

Key:
Cal-IPC = California Invasive Plant Council
CDFA = California Department of Food and Agriculture

Upper Sacramento River (Shasta Dam to Red Bluff) and Lower Sacramento River and Delta

A number of nonnative species have been introduced and become abundant in the riparian areas and marshes (fresh emergent wetlands) of the Sacramento Valley and Delta (Hunter et al. 2003). Several of these invasive nonnatives, including red sesbania (*Sesbania punicea*), Himalayan blackberry (*Rubus discolor*), giant reed (*Arundo donax*), and perennial pepperweed (*Lepidium latifolium*), form dense, monotypic stands that preclude the establishment of native species (Bossard, Randall, and Hoshovsky 2000). In general, these species displace native plants, reduce biodiversity, alter river flows, and reduce wildlife habitat values. Table 12-8 lists the most problematic of those species in Sacramento Valley and Delta riparian areas and marshes—invasive species rated by Cal-IPC; many of these species have severe ecological impacts on physical processes, plant and animal communities, and vegetation structure (Cal-IPC 2006).

Table 12-8. Cal-IPC High-Rated Invasive Plants of Sacramento Valley and Delta Riparian and Marsh Habitats

Scientific Name Common Name	Cal-IPC Rating[1]	CDFA Rating[2]	Primary Riparian/ Marsh Habitat(s)	Plant Type
Ailanthus altissima Tree-of-heaven, Chinese sumac	M	C	Marsh, riparian forest/woodland/scrub	Tree
Arundo donax Giant reed	H	B	Riparian forest/scrub	Perennial grass
Bromus diandrus Ripgut brome, great brome	M	–	Riparian scrub	Annual grass
Bromus madritensis ssp. *rubens* Red brome, foxtail chess	H	–	Riparian woodland/scrub	Annual grass
Centaurea melitensis Malta starthistle, tocalote	M	C	Riparian scrub	Annual herb
Centaurea solstitialis Yellow starthistle	H	C	Riparian scrub	Annual herb
Cirsium vulgare Bull thistle	M	C	Marsh	Perennial herb
Conium maculatum Poison hemlock	M	–	Riparian forest	Perennial herb
Cortaderia selloana, Cortaderia jubata Pampasgrass, white pampasgrass, jubatagrass	H	B	Riparian scrub	Perennial grass
Delairea odorata Cape-ivy, German ivy	H	–	Riparian forest	Perennial vine
Dipsacus fullonum Common teasel, wild teasel	M	–	Bog and fen, riparian scrub, marsh	Perennial herb
Egeria densa Brazilian waterweed, egeria	H	C	Lakes, ponds, reservoirs	Perennial aquatic herb
Eucalyptus globules Bluegum, Tasmanian bluegum	M	–	Marsh, riparian forest/woodland	Tree
Ficus carica Edible fig	M	–	Riparian forest, marsh	Shrub/tree
Foeniculum vulgare fennel	H	–	Riparian scrub/woodland	Perennial herb
Geranium dissectum Cutleaf geranium	L	–	Riparian woodland	Annual herb
Hedera helix, Hedera canariensis English ivy and Algerian ivy	H	–	Riparian forest, marsh	Perennial vine/shrub
Hypochaeris glabra Smooth cat's-ear	L	–	Riparian woodland	Annual herb
Hypochaeris radicata Common cat's ear, rough cat's-ear	M	–	Riparian forest/woodland/scrub	Annual herb

Table 12-8. Cal-IPC High-Rated Invasive Plants of Sacramento Valley and Delta Riparian and Marsh Habitats (contd.)

Scientific Name Common Name	Cal-IPC Rating[1]	CDFA Rating[2]	Primary Riparian/ Marsh Habitat(s)	Plant Type
Lepidium latifolium Perennial pepperweed, tall whitetop	H	B	Tidal and nontidal marsh, riparian scrub	Perennial herb
Lolium multiforum, Festuca perennis Italian ryegrass	M	–	Riparian scrub	Annual/biennial grass
Ludwigia peploides Creeping waterprimrose, California waterprimrose	H	–	Rivers, streams, canals	Perennial aquatic herb
Lytrum hyssopifolium Hyssop loosestrife, grass poly	L	–	Marsh	Perennial herb
Lythrum salicaria Purple loosestrife	H	B	Tidal and nontidal marsh	Perennial herb
Mentha pulegium Pennyroyal, European pennyroyal	M	–	Marsh, bog and fen, riparian forest	Perennial herb
Myoporum laetum Ngaio tree, false sandalwood	M	–	Marsh	Shrub/tree
Myriophyllum spicatum Spike watermilfoil	H	C	Lakes, ponds, reservoirs	Perennial aquatic herb
Potamogeton crispus Curly-leaved pondweed, curled pondweed	M	–	Lakes, ponds, reservoirs, rivers, streams, canals	Perennial aquatic herb
Pyracantha angustifolia, P. crenulata, P. coccinea Narrowleaf firethorn, scarlet firethorn	L	–	Riparian woodland	Shrub
Ranunculus repens Creeping buttercup	L	–	Riparian forest/woodland	Perennial herb
Rubus armeniacus (= R. discolor) Himalayan blackberry	H	–	Riparian woodland/forest/scrub, nontidal marsh	Shrub
Rumex acetosella Sheep sorrel	M	–	Riparian scrub	Perennial herb
Rumex crispus Curly dock	L	–	Bog and fen, riparian forest/woodland	Perennial herb
Saponaria officinalis Bouncing-bet, bouncing betty	L	–	Riparian woodland	Perennial herb
Sesbania punicea Red sesbania, scarlet wisteria	H, A	B	Riparian woodland, marsh	Tree
Tamarix chinensis, T. gallica, T. parviflora, T. ramosissima Chinese tamarisk, French tamarisk, small flower tamarisk, salt cedar	H	B	Riparian forest/woodland, marsh	Tree, shrub
Torilis arvensis Hedgeparsley, spreading hedgeparsley	M	–	Riparian woodland	Annual herb

Table 12-8. Cal-IPC High-Rated Invasive Plants of Sacramento Valley and Delta Riparian and Marsh Habitats (contd.)

Scientific Name Common Name	Cal-IPC Rating[1]	CDFA Rating[2]	Primary Riparian/ Marsh Habitat(s)	Plant Type
Verbascum thapsus Common mullein, wooly mullein	L	–	Riparian scrub	Perennial herb

Source: Cal-IPC 2006

Notes:

[1] Cal-IPC Inventory Ratings:

A = Alert – Plant species with the potential to spread explosively; infestations currently small and localized

H = High – species that have severe ecological impacts on physical processes, plant and animal communities, and vegetation structure

M = Moderate –species that have substantial and apparent, but generally not severe, ecological impacts on physical processes, plant and animal communities, and vegetation structure

L = Limited –species that are invasive but their impacts are minor on a statewide level or there was not enough information to justify a higher score

[2] CDFA Weed Ratings:

B = known to be of economic or environmental detriment, and of limited distribution, if present in California

C = known to be of economic or environmental detriment, and usually widespread, if present in California

Key:

Cal-IPC = California Invasive Plant Council

CDFA = California Department of Food and Agriculture

12.1.4 Waters of the United States, Including Wetlands, in Shasta Lake and Vicinity

Reclamation delineated wetlands and other waters of the United States under Federal jurisdiction (jurisdictional waters) in the impoundment area between 2004 and 2010. Jurisdictional waters on public lands in the relocation areas were delineated between 2009 and 2013, and on private lands where access was granted. Supplemental fieldwork is planned for additional private lands in the relocation areas where access has recently been granted. These data will be provided in a wetland delineation report prepared for submittal to the USACE. The wetland delineation report is in preparation and has not been verified by the USACE. All information regarding jurisdictional waters is preliminary.

Jurisdictional waters occur in the impoundment and relocation areas as wetlands and other waters. For wetlands, the impoundment area is defined as the area between 1,070 and 1,090 msl surrounding Shasta Lake. For other waters, the impoundment area includes the lacustrine waters associated with Shasta Lake below 1,070 msl. Wetlands include fresh emergent/riparian wetland, intermittent swale, riparian wetland, seasonal wetland, seep/spring wetland, and vegetated ditch. Other waters include ephemeral, intermittent, and perennial streams, roadside ditches, seep/spring waters, and lacustrine. Because some construction activities associated with the impoundment and relocation areas extend into Shasta Lake below the existing full pool elevation, the surface area of the lake is included in the delineation results. Approximately 46 acres of wetlands and 30,092 acres of other waters occur in the impoundment and relocation areas. Total jurisdictional waters in the impoundment and relocation areas, excluding Shasta Lake at full pool, include approximately 51 acres of wetlands and 103 acres of other waters.

Jurisdictional waters occur in the potential Sacramento River downstream restoration areas as wetlands and other waters. Wetlands include fresh emergent wetlands, pond, riparian wetlands, and riparian/fresh emergent wetland complex. Other waters include ephemeral, intermittent, and perennial streams. Approximately 67 acres of wetlands and 100 acres of other waters occur in the potential Sacramento River downstream restoration areas.

Main Body

The wetland delineation of the impoundment area along the Main Body was conducted from January to April 2010. Jurisdictional waters include seep/spring, riparian, and vegetated ditch wetlands and ephemeral stream, intermittent stream, and perennial stream, seep/spring, and roadside ditch waters. Total acres of jurisdictional waters occurring in the Main Body are summarized in Table 12-9.

Big Backbone Arm

The wetland delineation along the Big Backbone Arm was conducted during November 2006. Jurisdictional waters included seep/spring and riparian wetlands, and ephemeral stream, intermittent stream, and perennial stream waters. Total acres of jurisdictional waters occurring in the Big Backbone Arm are summarized in Table 12-9.

Sacramento Arm

The wetland delineation along the Sacramento Arm was conducted from September through early December 2010 and during March, April, and June 2010. Jurisdictional waters include seep/spring, riparian, seasonal, and riparian/fresh emergent wetlands, and ephemeral stream, intermittent stream, and perennial stream, seep/spring, and roadside ditch waters. Total acres of jurisdictional waters occurring in the Sacramento Arm are summarized in Table 12-9.

McCloud Arm

The wetland delineation along the McCloud Arm was conducted during December 2009 and in April, June, and November 2010. Jurisdictional waters include seep/spring, riparian, and vegetated ditch wetlands and ephemeral stream, intermittent stream, perennial stream, and seep/spring waters. Total acres of jurisdictional waters occurring in the McCloud Arm are summarized in Table 12-9.

Squaw Creek Arm

The wetland delineation along the Squaw Creek Arm was conducted from late August through September 2004. Jurisdictional waters include seep/spring, riparian, and seasonal wet meadow wetlands, and ephemeral stream, intermittent stream, perennial stream, and seep/spring other waters. Total acres of jurisdictional waters occurring in the Squaw Creek Arm are summarized in Table 12-9.

Pit Arm

The wetland delineation along the Pit Arm was conducted from late November 2006 through April 2007. Jurisdictional waters include riparian, seep/spring, seasonal and intermittent swale wetlands, and ephemeral stream, intermittent stream, and perennial stream waters. Total acres of jurisdictional waters occurring in the Pit Arm are summarized in Table 12-9.

Table 12-9. Jurisdictional Waters in the Impoundment Area

Jurisdictional Water Type	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Wetlands							
Fresh emergent/ riparian wetland	0.00	0.00	5.32	0.00	0.00	0.00	5.32
Intermittent swale	0.00	0.00	0.00	0.00	0.00	0.04	0.04
Riparian wetland	1.09	1.73	7.05	8.34	1.49	0.77	20.47
Seasonal wetland	0.00	0.00	0.42	0.00	0.14	0.02	0.58
Seep/spring wetland	0.77	0.23	0.80	0.41	0.16	0.47	2.84
Vegetated ditch	0.13	0.00	0.00	0.02	0.00	0.00	0.15
Total Wetlands	1.99	1.96	13.59	8.77	1.79	1.30	29.40
Other Waters of the United States							
Ephemeral stream	0.28	0.01	0.62	0.28	0.13	0.12	1.44
Intermittent stream	1.42	0.24	2.42	0.91	0.92	2.58	8.49
Perennial stream	1.55	3.00	9.78	20.27	2.39	1.57	38.56
Roadside ditch	0.00	0.00	0.01	0.00	0.00	0.00	0.01
Seep/spring other waters	0.03	0.00	0.001	0.01	0.0001	0.00	0.04
Lacustrine[2]	10,196.88	1,014.12	7,225.14	5,032.68	2,081.60	4,372.80	29,923.22
Total Other Waters	10,200.16	1,017.37	7,237.97	5,054.15	2,085.04	4,377.07	29,971.76
Total Waters of the U.S.	10,200.15	1,019.33	7,251.56	5,062.92	2,086.83	4,378.37	30,001.16

Notes:
[1] Acreage values are approximate
[2] Lacustrine acreage includes area below 1070 msl

Relocation Areas

Wetland delineations at the relocation areas were conducted between January 2010 and September March 2013. Jurisdictional waters include wetlands and other waters. Wetlands include fresh emergent, intermittent swale, riparian, seep/spring, and seasonal wetlands, and vegetated ditches. Other waters present include ephemeral, intermittent, and perennial streams, seep/spring, and roadside ditches. Total acres of jurisdictional waters occurring in the Relocation Areas are summarized in Table 12-10.

Table 12-10. Jurisdictional Waters in the Relocation Areas

Jurisdictional Water Type	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Wetlands							
Fresh emergent wetland	0.00	N/A	0.07	0.01	0.00	0.00	0.07
Fresh emergent/ riparian wetland	0.00	N/A	0.40	0.00	0.00	0.00	0.40
Intermittent swale	0.00	N/A	0.78	0.00	0.00	0.01	0.78
Riparian wetland	0.15	N/A	3.55	0.39	0.17	0.13	4.39
Seasonal wetland	0.01	N/A	11.30	0.00	0.02	0.00	11.33
Seep/spring wetland	0.03	N/A	0.06	0.12	0.05	0.16	0.42
Vegetated ditch	0.06	N/A	0.002	0.01	0.002	0.00	0.07
Total Wetlands	0.25	N/A	16.16	0.52	0.24	0.29	17.46
Other Waters of the United States							
Ephemeral stream	0.24	N/A	1.16	0.85	0.03	0.09	2.37
Intermittent stream	0.78	N/A	2.96	1.25	0.20	0.33	5.52
Perennial stream	0.00	N/A	0.28	0.54	0.24	0.002	1.06
Non-vegetated ditch	0.04	N/A	0.12	0.00	0.00	0.00	0.16
Roadside ditch	0.00	N/A	0.003	0.00	0.00	0.00	0.003
Seep/spring other waters	0.00	N/A	0.00	0.00	0.03	0.00	0.03
Total Other Waters	1.02	N/A	4.40	2.64	0.50	0.42	8.98
Total Waters of the U.S.	1.31	N/A	20.68	3.16	0.74	0.71	26.60

Note:
[1] Acreage values are approximate.
Key: N/A = Not Applicable

Potential Sacramento River Downstream Restoration Areas

Wetland delineations at the potential Sacramento River downstream restoration areas were conducted between March and November 2013. Jurisdictional waters occur in the potential Sacramento River downstream restoration areas as wetlands and other waters. Wetlands include fresh emergent wetlands, pond, riparian wetlands, and riparian/fresh emergent wetland complex. Other waters include ephemeral, intermittent, and perennial streams. Approximately 67 acres of wetlands and 100 acres of other waters occur in the potential Sacramento River downstream restoration areas. Total acres of jurisdictional waters occurring in the relocation areas are summarized in Table 12-11.

Table 12-11. Jurisdictional Waters in the Potential Sacramento River Downstream Restoration Areas

Jurisdictional Water Type	Area (Acres[1])					
	Henderson Open Space	Tobiasson Island	Shea Island Complex	Kapusta Island	Anderson River Park	Reading Island
Wetlands						
Fresh emergent wetland	1.16	0.68	1.07	0.15	9.19	5.14
Riparian wetland	1.88	1.58	4.64	10.23	12.09	15.24
Riparian/fresh emergent wetland complex	N/A	N/A	0.05	N/A	3.62	N/A
Total Wetlands	3.04	2.26	5.76	10.38	24.9	17.38
Other Waters of the United States						
Ephemeral stream	0.01	N/A	N/A	N/A	N/A	N/A
Intermittent stream	N/A	N/A	N/A	N/A	0.02	0.02
Perennial stream	1.34	3.12	10.93	8.83	0.68	4.59
Pond	3.51	N/A	N/A	N/A	N/A	N/A
Total Other Waters	4.86	3.12	10.93	8.83	0.70	4.61
Total Waters of the U.S.	7.89	5.38	16.69	19.21	25.59	24.99

Note:
[1] Acreage values are approximate.

Characterization of Wetland Features

Jurisdictional wetlands occurring in the Shasta Lake and vicinity portion of the primary study area include fresh emergent/riparian wetland, intermittent swale, riparian wetland, seasonal wetland, seep/spring wetland, and vegetated ditch.

Fresh emergent/riparian wetlands are uncommon in the Shasta Lake and vicinity portion of the primary study area, occurring only at one location along the Sacramento Arm. This location consists of a former USFS recreation site developed at the confluence of Salt Creek and Shasta Lake, immediately east of I-5. This former recreation site coupled with an undercrossing at I-5 has partially impounded the flows of Salt Creek, resulting in the development of an area characterized by a complex of fresh emergent and riparian wetland vegetation. Dominant overstory species include Goodding's black willow (OBL[1]), arroyo willow (FACW), red willow (assume FACW), and shining willow (OBL). Fresh emergent species include pennyroyal (*Mentha pulegium*–OBL), willow dock (*Rumex salicifolius*–OBL), and broadleaf cattail (*Typha latifolia*). Wetland hydrology and soils criteria are met through evidence of frequent flooding, including sediment deposits, watermarks, drift lines, and drainage patterns.

Intermittent swales occur along the Big Backbone and Pit arms. These features are characterized as linear, or somewhat linear, drainages that lack evidence of scour and are dominated by wetland plant species resulting from seasonally saturated soils. Typical species occurring in these features include seep monkey flower (*Mimulus guttatus*–OBL), spiny fruit buttercup (*Ranunculus muricatus*–FACW), slender rush (*Juncus tenuis*–FACW), and centaury (*Centaurium venustum*–Not Listed (NL)). Wetland hydrology and soils criteria are met through evidence of long-duration saturation, including saturation in the upper 12 inches, aquic moisture regime, and drainage patterns.

Riparian wetlands are common throughout the Shasta Lake and vicinity portion of the primary study area and generally occur as "stringers," or narrow features found immediately adjacent to intermittent or perennial streams. Typical species found in riparian wetlands include arroyo willow (FACW), Goodding's black willow (OBL), white alder (FACW), Oregon ash (FACW), Indian rhubarb (*Darmera peltata*-NL), mugwort (*Artemisia douglasiana*-FACW), California wild grape (FACW), and Himalayan blackberry (FACW). Wetland hydrology and soils criteria are met through evidence of frequent flooding, including sediment deposits, watermarks, drift lines, and drainage patterns.

Seasonal wetlands occur along the Sacramento, Squaw Creek, and Pit arms. These features are dominated by herbaceous vegetation and are typically adjacent to other wetland features or are depressions that frequently pond. Typical plant species found in these features include slender rush (FACW), sword leaf rush (*Juncus ensifolius*–FACW), seep monkey flower (OBL), yampah (*Perideridia californica*–FACW), annual checker bloom (*Sidalcea calycosa*–OBL), little quaking grass (*Briza minor*–FACW), California oatgrass (*Danthonia californica*–FACW), and spiny fruit buttercup (FACW). Wetland hydrology and soils criteria are met through evidence of long-duration saturation, including saturation in the upper 12 inches, an aquic moisture regime, and drainage patterns.

[1] OBL = Obligate Wetland Plants—Estimated probability of occurring in wetland >99 percent.
FACW = Facultative Wetland Plants—Estimated probability of occurring in wetland >67 percent to 99 percent.
FAC = Facultative Plants—Estimated probability of occurring in wetland 33 percent to 67 percent.
FACU = Facultative Upland Plants—Estimated probability of occurring in wetland 1 percent to <33 percent.
UPL = Obligate Upland Plants—Estimated probability of occurring in wetland <1 percent.
NI = No Indicator—Plants for which insufficient information was available to determine an indicator status.
NL = Not listed—Plants not listed in Reed 1988.

Seep/spring wetlands are found throughout the Shasta Lake and vicinity portion of the primary study area. These features form at locations where groundwater flows meet the ground surface. Hydrophytic vegetation typically colonizes the area where water is provided by the seep/spring. Typical species include white alder (FACW), chain fern (*Woodwardia fimbriata*–FACW), goat's beard (*Aruncus dioicus*–FACW), Indian rhubarb (NL), seep monkey flower (OBL), horsetail (*Equisetum arvense*–FAC), red stem dogwood (*Cornus stolonifera*–FACW), spicebush (NL), and western azalea (FAC). The wetland hydrology and soils criteria are met through evidence of long-duration saturation, including inundation, saturation in the upper 12 inches, watermarks, and drainage patterns.

Vegetated ditches are uncommon in the Shasta Lake and vicinity portion of the primary study area and occur along the Main Body, the McCloud Arm, and in several relocation areas. These features consist of ditches that have been excavated to drain adjacent uplands, parking areas, roads, or railways. These features are generally low gradient and provide hydrologic conditions suitable for colonization by hydrophytic vegetation. Dominant plant species include nutsedge (*Cyperus eragrostis*–FACW), seep monkey flower (OBL), broadleaf cattail, and rush (*Juncus* sp.–assume FACW). Wetland hydrology and soil criteria were met by long-duration inundation and long-duration saturation.

Jurisdictional waters (i.e., other waters) occurring in the Shasta Lake and vicinity portion of the primary study area include ephemeral, intermittent, and perennial streams, roadside ditches, and seep/spring waters.

Ephemeral streams are common throughout the Shasta Lake and vicinity portion of the primary study area. These features are linear drainages characterized by indicators of scour and deposition, minor drift lines, and sediment deposits, but lack a groundwater component that contributes to their flow. The wetland hydrology is provided by sheet flow and these features typically cease flowing soon after storm or runoff events. Ephemeral streams are characterized by poorly defined wetland hydrology indicators, and are typically found in headwater areas with relatively small drainage areas.

Intermittent streams are the most common jurisdictional feature in the Shasta Lake and vicinity portion of the primary study area. Intermittent streams range from small, poorly defined tributaries to larger, well-defined streams that flow into the summer. Like ephemeral streams, intermittent streams flow seasonally, but, in addition to precipitation and sheet flow from adjacent slopes, these features have a groundwater component to their flow regime. Intermittent streams are characterized by the presence of a defined bed and bank, and scour and deposition. Other characteristics, such as algae growth or hydrophytic vegetation in or adjacent to the stream, indicate longer inundation periods. Wetland hydrology and hydric soil criteria are met through evidence of frequent flooding, including water marks, algal matting, drift lines, and sediment deposits.

Perennial streams occur throughout the Shasta Lake and vicinity portion of the primary study area. These features are characterized by perennial flow and often bounded by riparian wetlands. Dominant substrates consist of boulders, bedrock, cobble, sand, and gravel. Wetland hydrology and hydric soil criteria are met through evidence of frequent flooding, including water marks, algal matting, drift lines, and sediment deposits.

Roadside ditches are uncommon in the Shasta Lake and vicinity portion of the primary study area but some are found along the Sacramento Arm. These ditch features occur near roadways and railroad tracks and have been excavated solely to drain uplands. Wetland vegetation is sparse or absent. The wetland boundaries were indicated by sediment and drift deposits.

Seep/spring other waters are uncommon in the Shasta Lake and vicinity portion of the primary study area but some are found along the Main Body, the Sacramento Arm, the McCloud Arm, and the Squaw Creek Arm. These features form at locations where groundwater flows meet the ground surface; however, the features are not dominated by hydrophytic vegetation. The wetland hydrology and soils criteria are met through evidence of long-duration saturation, including inundation, saturation in the upper 12 inches, watermarks, and drainage patterns.

12.2 Regulatory Framework

Biological resources in California are protected and/or regulated by a variety of Federal and State laws and policies. In addition, in many parts of California, there are local or regional habitat and species conservation planning efforts in which a project applicant may participate. Key regulatory and conservation planning issues applicable to the project and alternatives under consideration are discussed below.

12.2.1 Federal

Endangered Species Act

Pursuant to the Federal Endangered Species Act (ESA), USFWS and NMFS have authority over projects that may result in "take" of a Federally listed species. In general, ESA Section 7 prohibits persons (including private parties) from "taking" listed endangered or threatened fish and wildlife species on private property, and from "taking" listed endangered or threatened plant species in areas under Federal jurisdiction or in violation of State law (16 United States Code (USC) 1532, 50 Code of Federal Regulations (CFR) 17.3). Under the ESA, the definition of "take" is to "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct" as part of an intentional or negligent act or omission. The term "harm" includes acts that result in death or injury to wildlife. Such acts may include significant habitat modification or degradation if it results in death or injury to wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Section 7(a) of the ESA, as amended, requires Federal agencies to evaluate their actions with respect to any species that is proposed for listing or is listed as endangered or threatened. Section 7(a)(2) requires Federal agencies to ensure that activities they authorize, fund, or carry out are not likely to jeopardize the continued existence of a listed species or to destroy or adversely modify its critical habitat. If a Federal action may affect a listed species or its critical habitat, the responsible Federal agency must enter into formal consultation with USFWS.

As defined in the ESA, critical habitat is a specific geographic area that is essential for the conservation of a threatened or endangered species and that may require special management and protection. It may include an area that is not currently occupied by the species but that will be needed for its recovery. Critical habitats are designated to ensure that actions authorized by Federal agencies will not destroy or adversely modify critical habitat, thereby protecting areas necessary for the conservation of the species.

Clean Water Act

The CWA is the major Federal legislation governing the water quality aspects of the SLWRI. The objective of the act is “to restore and maintain the chemical, physical, and biological integrity of the nation’s waters.” The CWA establishes the basic structure for regulating discharge of pollutants into the waters of the United States and gives EPA the authority to implement pollution control programs, such as setting wastewater standards for industries. In certain states, such as California, EPA has delegated authority to State agencies.

Section 303 of the CWA requires states to adopt water quality standards for all surface waters of the United States. The three major components of water quality standards are designated users, water quality criteria, and antidegradation policy. Section 303(d) of the CWA requires states and authorized Native American tribes to develop a list of water-quality-impaired segments of waterways. The list includes waters that do not meet water quality standards necessary to support the beneficial uses of a waterway, even after point sources of pollution have had minimum required levels of pollution control technology installed. Only waters impaired by “pollutants” (e.g., clean sediments, nutrients such as nitrogen and phosphorus, pathogens, acids/bases, temperature, metals, cyanide, and synthetic organic chemicals (EPA 2002)), not those impaired by other types of “pollution” (e.g., altered flow, channel modification), are to be included on the list.

Section 303(d) of the CWA also requires states to maintain a list of impaired water bodies so that a total maximum daily load (TMDL) can be established A TMDL is a plan to restore the beneficial uses of a stream or to otherwise correct an impairment. It establishes the allowable pollutant loadings or other quantifiable parameters (e.g., pH, temperature) for a water body and thereby provides the basis for establishing water-quality-based controls. The calculation for establishing TMDLs for each water body must include a margin of safety to ensure that the water body can be used for the purposes of state designation. Additionally, the calculation also must account for seasonal variation in water quality (EPA 2002). The Central Valley Regional Water Quality Control Board (RWQCB) develops TMDLs for Shasta Lake and its tributaries.

Section 401 of the CWA requires entities to obtain certification from the state or Native American tribes when applying for a Federal license or permit that may result in increased pollutant loads to a water body. The certification is issued only if such increased loads would not cause or contribute to exceedences of water quality standards.

Section 402 created the National Pollutant Discharge Elimination System (NPDES) permit program. This program covers point sources of pollution discharging into a surface water body.

A permit must be obtained from USACE under Section 404 for the discharge of dredged or fill material into “waters of the United States, including wetlands.” Waters of the United States include wetlands and lakes, rivers, streams, and their tributaries. Wetlands are defined for regulatory purposes as areas inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support and, under normal circumstances do support, vegetation typically adapted for life in saturated soil conditions.

Rivers and Harbors Act

USACE regulates the construction of structures in, over, or under; excavation of material from; or deposition of material into “navigable waters of the United States” under Section 10 of the Federal Rivers and Harbors Act (33 USC 401 et seq.). Navigable waters of the United States are defined as those waters subject to the ebb and flow of the tide shoreward to the mean high-water mark or those that are currently used, have been used in the past, or may be susceptible to use to transport interstate or foreign commerce.

U.S. Forest Service Sensitive Species

The National Forest Management Act requires USFS to “provide for a diversity of plant and animal communities” (16 USC 1604(g)(3)(B)) as part of its multiple-use mandate. USFS must maintain “viable populations of existing native and desired nonnative species in the planning area” (36 CFR 219.19). The Sensitive Species program is designed to meet this mandate and to demonstrate USFS’s commitment to maintaining biodiversity on National Forest System lands. The program is a proactive approach to conserving species to prevent a trend toward listing under the ESA and to ensure the continued existence of viable, well-distributed populations. A “Sensitive Species” is any species of plant or animal that has been recognized by the Regional Forester to need special management to prevent the species from becoming threatened or endangered.

Shasta-Trinity National Forest Land and Resource Management Plan

The Shasta-Trinity National Forest (STNF) Land and Resource Management Plan (LRMP) contains forest goals, standards, and guidelines designed to guide the management of STNF. The following goals, standards, and guidelines related to botanical resource issues associated with the primary study area were excerpted from the STNF LRMP (USFS 1995).

Biological Diversity

Goals (LRMP, p. 4-4) Integrate multiple resource management on a landscape level to provide and maintain diversity and quality of habitats that support viable populations of plants, fish, and wildlife.

Standards and Guidelines (LRMP, p. 4-14)

- **Natural Openings –** Management of natural openings will be determined at the project level consistent with desired future conditions.

- **Snags –** Over time, provide the necessary number of replacement snags to meet density requirements as prescribed for each land allocation and/or management prescription. Live, green culls and trees exhibiting decadence and/or active wildlife use are preferred.

- **Hardwood –** Apply the following standards in existing hardwood types:

  – Manage hardwood types for sustainability.

  – Conversion to conifers will only take place to meet desired future ecosystem conditions.

  – Where hardwoods occur naturally within existing conifer types on suitable timber lands, manage for a desired future condition for hardwoods as identified during ecosystem analysis consistent with management prescription standards and guidelines. Retain groups of hardwoods over single trees.

Threatened, Endangered, and Sensitive Species (Plants and Animals)

Goals (LRMP, p. 4-5)

- Monitor and protect habitat for Federally listed threatened and endangered and candidate species. Assist in recovery efforts for threatened and endangered species. Cooperate with the State to meet objectives for state listed species.

- Manage habitat for sensitive plants and animals in a manner that will prevent any species from becoming a candidate for threatened and endangered status.

Botany (Sensitive and Endemic Plants)

Standards and Guidelines (LRMP, pp. 4-14 through 4-16)

- Map, record, and protect essential habitat for known and newly discovered sensitive and endemic plant species until conservation strategies are developed.
- Analyze the potential effects of all ground-disturbing projects on sensitive and endemic plants and their habitat. Mitigate project effects to avoid a decline in species viability at the Forest level.
- Monitor the effects of management activities on sensitive and endemic plants. If monitoring results show a decline in species viability, alter management strategy.
- Provide reports of sensitive plant populations to the CDFW annually.
- Coordinate sensitive plant inventory and protection efforts with CDFW, USFWS, The Nature Conservancy (TNC), the CNPS, and other concerned agencies, organizations, and adjacent landowners.
- Protect type localities of sensitive and endemic plants for their scientific value.

U.S. Forest Service Survey and Manage

Standards and Guidelines The 1994 Record of Decision (ROD) for Amendments to USFS and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl and Standards and Guidelines for Management for Late-Successional and Old-Growth Related Species in the Range of the Northern Spotted Owl (Northwest Forest Plan (NWFP) ROD amended or was incorporated into BLM and USFS land management plans to require certain actions for rare amphibians, mammals, bryophytes, mollusks, vascular plants, fungi, lichens, and arthropods that occupy late-successional and old-growth forests (USFS and BLM 1994). These rare species were identified in Appendix C of the NWFP ROD collectively as S&M Species. The NWFP ROD also established protection buffers on matrix lands for certain species (i.e., protection buffer species) that were not on the 1994 S&M list and required that those buffers be managed as part of the Late Successional Reserve network. Four survey strategies were developed to guide management of S&M species: (1) manage known sites; (2) survey before ground-disturbing activities; (3) conduct extensive surveys; and (4) conduct general regional surveys.

The NWFP ROD also established overall objectives for managing S&M species populations that were referred to as “persistence objectives.” These objectives were based on the USFS viability provision in the 1982 National Forest System Land and Resource Management Planning Regulation for the National Forest Management Act of 1976. This provision is targeted toward vertebrate species, but was also applied to nonvertebrate species to the extent practicable, as described in the NWFP ROD. The provision generally states that the USFS shall manage habitat “to maintain viable populations of existing native and desired non-native vertebrate species in the planning area” (36 CFR 219.19). Although the viability standard is part of the USFS planning regulations, the protections for S&M species were also applied to BLM lands in the NWFP ROD with a goal of protecting the long-term health and sustainability of all Federal forests within the range of the northern spotted owl and the species that inhabit them. Because of the uncertainty associated with the continued persistence of species due to natural factors, the NWFP ROD noted that compliance with the planning regulations is not subject to precise numerical interpretations and cannot be fixed at any single threshold; rather, “as in any administrative field, common sense and agency expertise must be applied” (NWFP ROD, p. 44).

In 2001, the *Record of Decision and Standards and Guidelines for Amendments to the Survey and Manage, Protection Buffer, and other Mitigation Measures Standards and Guidelines* (2001 S&M ROD) (USFS and BLM 2001) modified the management direction provided in the NWFP ROD for S&M and protection buffer species and amended BLM and USFS land management plans in the range of the northern spotted owl accordingly. The list of S&M species was also modified to remove 72 species in all or part of their range because new information indicated they were secure or otherwise did not meet the basic criteria for S&M. Species remaining on the list were assigned to one of six categories using the following criteria: their relative rarity, the ability to reasonably and consistently locate occupied sites during surveys before habitat-disturbing activities, and the level of information known about the species or group of species. The 2001 S&M ROD also removed the direction specific to protection buffer species, excluding these species from S&M Standards and Guidelines requirements. As part of the 2001 Standards and Guidelines, objectives, criteria, and management direction were defined for each category. Specific criteria were also established to add, remove, or change species categories based on new information and as part of the annual species review processes.

In 2004 and again in 2007, the BLM and USFS issued a ROD to eliminate the S&M requirements of the 2001 S&M ROD and to provide protection for species on the S&M lists by managing them under the agencies’ special-status species programs. As a result of litigation, the requirements of the 2001 S&M ROD were reinstated. In a subsequent court-mandated settlement agreement (USFS and BLM 2011), the list of S&M species was modified. The settlement agreement also made the following modifications: (1) acknowledged existing exemption categories (2006 Pechman Exemptions), (2) updated the 2001 S&M species list, (3) established a transition period for application of the species list, and (4) established new exemption categories (2011 Exemptions). Agency decisions made after September 30, 2012, are required to use the 2011 S&M list. Some species considered in the S&M program also occur on non-Federal lands. The requirements of the 1994 NWFP ROD and 2001 S&M ROD as modified under the 2011 Settlement Agreement apply only to lands managed by the BLM and USFS within the range of the northern spotted owl. The 2011 Settlement Agreement was later struck down by the court, and the S&M program has reverted to the 2001 S&M ROD with the 2006 Pechman Exemptions still intact.

Management Guide for the Shasta and Trinity Units of the Whiskeytown-Shasta-Trinity National Recreation Area

A portion of the Shasta Unit of the Whiskeytown-Shasta-Trinity National Recreation Area is included in the Shasta Lake and vicinity portion of the primary study area. The 2014 NRA Management Guide for the Shasta and Trinity Units of the NRA contains management guidance intended to achieve or maintain a desired condition. This guidance takes into account opportunities, management recommendations for specific projects, and mitigation measures needed to achieve specific goals. The following guidance related to strategies for botanical and wetland resource issues associated with the Shasta Lake and vicinity portion of the primary study area were excerpted from the NRA Management Guide (USFS 2014).

- Protect known populations of threatened, endangered and sensitive plant, lichen, and fungi species and their habitats, and implement mitigation measures if necessary to maintain or enhance their continued viability. Conservation strategies for these species will be used as they are developed. Survey for special-status plants, lichens and fungi before ground-disturbing projects.

- Follow the national direction for the use of native plant materials in the revegetation, restoration, and rehabilitation of NFS lands. This includes making native plant materials the first choice in revegetation for restoration and rehabilitation of native ecosystems where timely natural regeneration of the native plant community will not occur.

- Do not authorize, fund, or carry out actions that are likely to cause or promote the introduction or spread of invasive species unless, pursuant to guidelines that it has prescribed, the USFS has determined and made public its determination that the benefits of such actions clearly outweigh the potential harm caused by invasive species; and that all feasible and prudent measures to minimize risk of harm will be taken in conjunction with the actions. An integrated approach for addressing invasive plant problems will be explored since it offers the most thoroughly effective treatment of invasive plants by using a variety of treatment options to eradicate, control, or contain invasive plants where they occur. The combination of treatment methods, including manual, mechanical, biological, controlled grazing, prescribed burning, cultural, and herbicidal methods, will be tailored to fit each site-specific situation and each type of invasive plant. By proposing several methods for invasive plant control, this approach recognizes that using only one management method is unlikely to be effective in all situations.

- Dead, dying and live defective trees are an important part of a healthy, functioning forest ecosystem. They play many ecological roles in forests such as altering plant succession and providing wildlife habitat. Retention of these types of trees is necessary to meet the needs of snag dependent species and ecosystem health.

U.S. Forest Service Noxious Weed Management Policy 20900

USFS Manual Policy 20900, Noxious Weed Management (USFS 2011), includes the following policy for the management of aquatic and terrestrial invasive species (including vertebrates, invertebrates, plants, and pathogens), based on an integrated pest management approach, throughout the National Forest System:

1. Initiate, coordinate, and sustain actions to prevent, control, and eliminate priority infestations of invasive species in aquatic and terrestrial areas of the National Forest System using an integrated pest management approach, and collaborate with stakeholders to implement cooperative invasive species management activities in accordance with law and policy.

2. When applicable, invasive species management actions and standards should be incorporated into resource management plans at the forest level, and in programmatic environmental planning and assessment documents at the regional or national levels.

3. Determine the vectors, environmental factors, and pathways that favor the establishment and spread of invasive species in aquatic and terrestrial areas of the National Forest System, and design management practices to reduce or mitigate the risk for introduction or spread of invasive species in those areas.

4. Determine the risk of introducing, establishing, or spreading invasive species associated with any proposed action, as an integral component of project planning and analysis, and where necessary provide for alternatives or mitigation measures to reduce or eliminate that risk before project approval.

5. Ensure that all USFS management activities are designed to minimize or eliminate the possibility of establishment or spread of invasive species on the National Forest System, or to adjacent areas. Integrate visitor use strategies with invasive species management activities on aquatic and terrestrial areas of the National Forest System. At no time are invasive species to be promoted or used in site restoration or re-vegetation work, watershed rehabilitation projects, planted for bio-fuels

production, or other management activities on national forests and grasslands.

6. Use contract and permit clauses to require that the activities of contractors and permittees are conducted to prevent and control the introduction, establishment, and spread of aquatic and terrestrial invasive species. For example, where determined to be appropriate, use agreement clauses to require contractors or permittees to meet USFS-approved vehicle and equipment cleaning requirements/standards before using the vehicle or equipment in the National Forest System.

7. Make every effort to prevent the accidental spread of invasive species carried by contaminated vehicles, equipment, personnel, or materials (including plants, wood, plant/wood products, water, soil, rock, sand, gravel, mulch, seeds, grain, hay, straw, or other materials).

    a. Establish and implement standards and requirements for vehicle and equipment cleaning to prevent the accidental spread of aquatic and terrestrial invasive species on the National Forest System or to adjacent areas.

    b. Make every effort to ensure that all materials used on the National Forest System are free of invasive species and/or noxious weeds (including free of reproductive/propagative material such as seeds, roots, stems, flowers, leaves, larva, eggs, veligers, and so forth).

8. Where States have legislative authority to certify materials as weed-free (or invasive-free) and have an active State program to make those State-certified materials available to the public, forest officers shall develop rules restricting the possession, use, and transport of those materials unless proof exists that they have been State-certified as weed-free (or invasive-free), as provided in 36 CFR 261 and Departmental Regulation 1512-1.

9. Monitor all management activities for potential spread or establishment of invasive species in aquatic and terrestrial areas of the National Forest System.

10. Manage invasive species in aquatic and terrestrial areas of the National Forest System using an integrated pest management approach to achieve the goals and objectives identified in Forest LRMPs, and other USFS planning documents, and other plans developed in cooperation with external partners for the management of natural or cultural resources.

11. Integrate invasive species management funding broadly across a variety of National Forest System programs, while associating the funding with the specific aquatic or terrestrial invasive species that is being

prioritized for management, as well as the purpose and need of the project or program objective.

12. Develop and use site-based and species-based risk assessments to prioritize the management of invasive species infestations in aquatic and terrestrial areas of the National Forest System. Where appropriate, use a structured decision making process and adaptive management or similar strategies to help identify and prioritize invasive species management approaches and actions.

13. Comply with the USFS performance accountability system requirements for invasive species management to ensure efficient use of limited resources at all levels of the Agency and to provide information for adapting management actions to meet changing program needs and priorities. When appropriate, use a structured decision-making process to address invasive species management problems in changing conditions, uncertainty, or when information is limited.

14. Establish and maintain a national record keeping database system for the collection and reporting of information related to invasive species infestations and management activities, including invasive species management performance, associated with the National Forest System. Require all information associated with the National Forest System invasive species management (including inventories, surveys, and treatments) to be collected, recorded, and reported consistent with national program protocols, rules, and standards.

15. Where appropriate, integrate invasive species management activities, such as inventory, survey, treatment, prevention, monitoring, and so forth, into the National Forest System management programs. Use inventory and treatment information to help set priorities and select integrated management actions to address new or expanding invasive species infestations in aquatic and terrestrial areas of the National Forest System.

16. Assist and promote cooperative efforts with internal and external partners, including private, State, tribal, and local entities, research organizations, and international groups to collaboratively address priority invasive species issues affecting the National Forest System.

17. Coordinate as needed with USFS Research and Development and State and Private Forestry programs, other agencies included under the National Invasive Species Council, and external partners to identify priority/high-risk invasive species that threaten aquatic and terrestrial areas of the National Forest System. Encourage applied research to

develop techniques and technology to reduce invasive species impacts to the National Forest System.

18. As appropriate, collaborate and coordinate with adjacent landowners and other stakeholders to improve invasive species management effectiveness across the landscape. Encourage cooperative partnerships to address invasive species threats within a broad geographical area.

U.S. Bureau of Land Management Resource Management Plan

BLM manages a number of public lands within the primary study area, including the Chappie-Shasta Off-Highway Vehicle Area west of Shasta Dam. These areas fall under the Northern California BLM district and the resource management plan of the Redding BLM field office. The purpose of BLM's resource management plan is to provide an overall direction for managing and allocating public resources in the planning area. BLM is responsible for administering the following strategies related to resource issues common to the portion of the Redding District lands located in the primary study area (BLM 1992, 1993).

- Provide a regional opportunity for motorized recreation with a focus within the Chappie-Shasta Off-Highway Vehicle Area.
- Enhance non-motorized recreation opportunities within the area via a greenway connecting Redding to Shasta Dam along the Sacramento River.
- Maintain or improve the long-term sustained yield of forest products available from commercial forest lands.
- Improve the long-term condition and protection of deer winter range habitat.
- Maintain special-status species habitat.
- Maintain the existing scenic quality of the areas.
- Maintain opportunities to explore and develop freely available minerals on public lands.

Executive Order 11990: Protection of Wetlands

Executive Order 11990 established the protection of wetlands and riparian systems as the official policy of the Federal government. It requires all Federal agencies to consider wetland protection as an important part of their policies and take action to minimize the destruction, loss, or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands.

Executive Order 11312: Invasive Species

Executive Order 11312 directs all Federal agencies to prevent and control introductions of invasive nonnative species in a cost-effective and environmentally sound manner to minimize their economic, ecological, and human health impacts. Executive Order 11312 established a national Invasive Species Council made up of Federal agencies and departments and a supporting Invasive Species Advisory Committee composed of State, local, and private entities. The Invasive Species Council and Advisory Committee oversee and facilitate implementation of the Executive Order, including preparation of a National Invasive Species Management Plan.

12.2.2 State

California Endangered Species Act

Under the California Endangered Species Act (CESA), CDFW has the responsibility for maintaining a list of endangered and threatened species (California Fish and Game Code, Section 2070). CDFW also maintains a list of "candidate species," which are species for which CDFW has issued a formal notice that they are under review for addition to the list of endangered or threatened species. Pursuant to the requirements of CESA, an agency reviewing a proposed project within its jurisdiction must determine whether any State-listed endangered or threatened species may be present in the project study area and, if so, whether the proposed project would have a potentially significant impact on any of these species. In addition, CDFW encourages informal consultation on any proposed project that may affect a species that is a candidate for state listing.

Project-related impacts on species listed as endangered or threatened under the CESA would be considered significant. "Take" of protected species incidental to otherwise lawful management activities may be authorized under Section 2081 of the California Fish and Game Code. Under the CESA, "take" is defined as an activity that would directly or indirectly kill an individual of a species, but the definition does not include "harm" or "harass," as the Federal act does. Therefore, the threshold for take may be higher under CESA than under ESA because habitat modification is not necessarily considered take under CESA.

Authorization from CDFW would be in the form of an incidental take permit or as a consistency determination (Section 2080.1(a) of the Fish and Game Code). Section 2080.1(a) of the Fish and Game Code authorizes CDFW to accept a Federal biological opinion as the take authorization for a state-listed species when a species is listed under both the ESA and the CESA.

California Native Plant Protection Act

The Native Plant Protection Act (California Fish and Game Code, Sections 1900–1913) prohibits the taking, possessing, or sale within the state of any plants with a State designation of rare, threatened, or endangered, as defined by

CDFW. The Act's definition of "endangered" and "rare" closely parallel the CESA definitions of "endangered" and "threatened" plant species.

Section 1602 of the California Fish and Game Code—Streambed Alteration

Diversions, obstructions, or changes to the natural flow or bed, channel, or bank of any river, stream, or lake in California that supports wildlife resources are subject to regulation by CDFW, pursuant to Section 1602 of the California Fish and Game Code. The regulatory definition of stream is a body of water that flows at least periodically or intermittently through a bed or channel that has banks and supports wildlife, fish, or other aquatic life. This includes watercourses that have a surface or subsurface flow that supports or has supported riparian vegetation. CDFW's jurisdiction within altered or artificial waterways is based on the value of those waterways to fish and wildlife. A CDFW streambed alteration agreement must be obtained for a project that would result in an impact on a river, stream, or lake.

Porter-Cologne Water Quality Control Act

The Porter-Cologne Water Quality Control Act requires that each of the nine RWQCBs prepare and periodically update basin plans for water quality control. Each basin plan sets forth water quality standards for surface water and groundwater and actions to control nonpoint and point sources of pollution to achieve and maintain these standards. Basin plans offer an opportunity to protect wetlands through the establishment of water quality objectives. The RWQCB's jurisdiction includes Federally protected waters as well as areas that meet the definition of "waters of the state." Waters of the state is defined as any surface water or groundwater, including saline waters, within the boundaries of the state. The RWQCB has the discretion to take jurisdiction over areas not Federally protected under Section 401 provided they meet the definition of waters of the state. Mitigation requiring no net loss of wetlands functions and values of waters of the state is typically required by the RWQCB.

California Department of Fish and Wildlife Species Designations

CDFW maintains an informal list of species called "species of special concern." These are broadly defined as wildlife species that are of concern to CDFW because of population declines and restricted distributions, and/or because they are associated with habitats that are declining in California. These species are inventoried in the CNDDB regardless of their legal status. Impacts on species of special concern may be considered significant.

California Department of Fish and Wildlife/California Native Plant Society Plant California Rare Plant Ranking System

CNPS is a statewide nonprofit organization that seeks to increase understanding of California's native flora and to preserve this rich resource for future generations. CDFW and CNPS assign rare plant ranks through the collaborative efforts of the Rare Plant Status Review Group composed of over 300 botanical experts from government, academia, non-government organizations, and the private sector and managed jointly by CDFW and CNPS. California native plants meeting the rarity or endangerment criteria are assigned a CRPR. These plants were formerly referred to as CNPS listed species; however, in March 2010, CDFW adopted the name CRPR for the rarity and endangerment categories to eliminate the false impression that these assignments are the exclusive work of CNPS and that CNPS has had undue influence over the regulatory process. CRPR 1 and 2 species generally qualify as endangered, rare, or threatened within the definition of State CEQA Guidelines CCR Section 15380. In general, CRPR 3 and 4 species do not meet the definition of endangered, rare, or threatened pursuant to CEQA Section 15380; however, these species may be evaluated by the lead agency on a case-by-case basis to determine significance criteria under CEQA.

California Department of Fish and Wildlife Special-Status Natural Communities Designations

CDFW maintains a list of plant communities that are native to California. On that list, CDFW identifies special-status natural communities (e.g., sensitive natural communities), which it defines as communities that are of limited distribution statewide or within a county or region, and are often vulnerable to the environmental effects of projects. Occurrences of special-status natural communities are included in the CNDDB; however, no new occurrences have been added to the CNDDB since the mid-1990s, when funding for tracking natural communities was eliminated. These correspond to communities with State rarity ranks of S1–S3: S1 = critically imperiled, S2 = imperiled, and S3 = vulnerable. These communities may or may not contain special-status species or their habitat. Because of their limited distribution in California, most types of wetlands and riparian communities are considered special-status natural communities. Impacts on special-status natural communities may be considered significant.

12.2.3 Local

Shasta, Tehama, Glenn, Sutter, Sacramento, and Yolo counties and the cities of Redding, Colusa, and Sacramento have established codes and policies that address protection of natural resources, including vegetation, sensitive species, and trees, and are applicable to the project.

Shasta County’s general plan emphasizes that the maintenance and enhancement of quality fish and wildlife habitat is critical to the recreation and tourism industry, and acknowledges that any adverse and prolonged decline of these resources could result in negative impacts on an otherwise vibrant industry. The general plan identifies efforts to protect and restore these habitats to sustain the long-term viability of the tourism and recreation industry (Shasta County 2004).

The City of Redding’s general plan strives to strike a balance between development and conservation by implementing several measures such as creek-corridor protection, sensitive hillside development, habitat protection, and protection of prominent ridge lines that provide a backdrop to the city (City of Redding 2000).

Tehama County's general plan (Tehama County 2009) update provides an overarching guide to future development and establishes goals, policies, and implementation measures designed to address potential changes in county land use and development. The general plan identifies the importance of retaining agriculture as one of the primary uses of land in Tehama County.

Glenn County's general plan provides a comprehensive plan for growth and development in Glenn County for the next 20 years (2007 to 2027). This plan recognizes that public lands purchased for wildlife preservation generate economic activity as scientists and members of the public come to view and study remnant ecosystems (Glenn County 1993).

The City of Colusa's general plan seeks to promote its natural resources through increased awareness and improved public access (City of Colusa 2007).

Sutter County's general plan contains policies that generally address preservation of natural vegetation, including wetlands. It requires that new development mitigate the loss of Federally protected wetlands to achieve "no net loss," but it does not include any other specific requirements.

Sacramento County's general plan contains policies that promote protection of marsh and riparian areas, including specification of setbacks and "no net loss" of riparian woodland or marsh acreage (Sacramento County 1993). It also addresses the need to conserve vernal pools and ephemeral wetlands to ensure no net loss of vernal pool acreage. Several policies specifically promote protection of native oak trees, and, in some areas of the county, seek to ensure that there is no net loss of canopy area. The general plan for the County of Sacramento is currently under revision.

The City of Sacramento Municipal Code addresses the protection of trees within the city boundaries, including general protection of all trees on city property and specific protection of heritage trees.

Yolo County's general plan aims to provide an active and productive buffer of farmland and open space separating the Bay Area from Sacramento, and integrating green spaces into its communities.

12.2.4 Federal, State, and Local Programs and Projects

California Bay-Delta Authority

The California Bay-Delta Authority (CBDA) was established as a State agency in 2003 to oversee implementation of CALFED for the numerous Federal and State agencies working cooperatively to improve the quality and reliability of California's water supplies while restoring the Bay-Delta ecosystem. The July 2000 CALFED *Final Programmatic EIS/EIR* (CALFED 2000b) analyzed a range of alternatives to address these needs and included a MSCS to provide a framework for compliance with ESA, CESA, and Natural Community Conservation Planning Act. The August 2000 CALFED Programmatic ROD identified 12 action plans, including Ecosystem Restoration, Watersheds, and Water Supply Reliability, among others (CALFED 2000d). The CALFED Ecosystem Restoration Program has provided a funding source for projects that include those involving acquisition of lands within the Sacramento River Conservation Area, initial baseline monitoring and preliminary restoration planning, and preparation of long-term habitat restoration management and monitoring plans. In 2009, the California Legislature passed sweeping water reform legislation, including the establishment of the Delta Stewardship Council (DSC). The DSC was transferred all the responsibilities, programs, staff and most of the funding from the CBDA, and the CBDA was dissolved. The DSC was also given additional mandates, including the development of a Delta Plan to guide activities and programs of State and local programs in the legal Delta through a consistency determination process.

Resource Conservation Districts

Numerous resource conservation districts (RCD) are within the primary study area. Once known as soil conservation districts, RCDs were established under California law with a primary purpose to implement local conservation measures. Although RCDs are locally governed agencies with locally appointed, independent boards of directors, they often have close ties to county agencies and the National Resources Conservation Service. RCDs are empowered to conserve resources within their districts by implementing projects on public and private lands and to educate landowners and the public about resource conservation. They are often involved in the formation and coordination of watershed working groups and other conservation alliances.
In the Shasta Lake and upper Sacramento River vicinity, districts include the Western Shasta County RCD and the Tehama County RCD. To the east are the Fall River and Pit River RCDs, and to the west and north are the Trinity County and Shasta Valley RCDs.

Riparian Habitat Joint Venture

The Riparian Habitat Joint Venture (RHJV) was initiated in 1994 and includes signatories from 18 Federal, State, and private agencies. The RHJV promotes conservation and the restoration of riparian habitat to support native bird populations through three goals:

- Promote an understanding of the issues affecting riparian habitat through data collection and analysis
- Double riparian habitat in California by funding and promoting on-the-ground conservation projects
- Guide land managers and organizations to prioritize conservation actions

RHJV conservation and action plans are documented in the Riparian Bird Conservation Plan (RHJV 2004). The conservation plan targets 14 "indicator" species of riparian-associated birds and provides recommendations for habitat protection, restoration, management, monitoring, and policy. The report notes habitat loss and degradation as one of the most important factors causing the decline of riparian birds in California. The RHJV has participated in monitoring efforts within the Sacramento National Wildlife Refuge Complex and other conservation areas. The RHJV's conservation plan identifies lower Clear Creek as a prime breeding area for yellow warblers and song sparrows, advocating a continuous riparian corridor along lower Clear Creek. Other recommendations of the conservation plan apply to the North Delta Offstream Storage Investigation study area in general.

Sacramento River Conservation Area Program

Senate Bill 1086 called for a management plan for the Sacramento River and its tributaries to protect, restore, and enhance both fisheries and riparian habitat. The Sacramento River Conservation Area Program has an overall goal of preserving remaining riparian habitat and reestablishing a continuous riparian ecosystem along the Sacramento River between Redding and Chico, and reestablishing riparian vegetation along the river from Chico to Verona. The program is to be accomplished through an incentive-based, voluntary river management plan. The Upper Sacramento River Fisheries and Riparian Habitat Management Plan (Resources Agency 1989) identifies specific actions to help restore the Sacramento River fishery and riparian habitat between the Feather River and Keswick Dam. The Sacramento River Conservation Area Forum Handbook (Resources Agency 2003) is a guide to implementing the program. The Keswick Dam-to-Red Bluff portion of the conservation area includes areas within the 100-year floodplain, existing riparian bottomlands, and areas of contiguous valley oak woodland, totaling approximately 22,000 acres. The 1989 fisheries restoration plan recommended several actions specific to the primary study area:

- Fish passage improvements at RBPP (under way; project final EIS/EIR released May 2008)
- Modification of the Spring Creek Tunnel intake for temperature control (completed)
- Spawning gravel replacement program (ongoing)
- Development of side-channel spawning areas, such as those at Turtle Bay in Redding (ongoing)
- Structural modifications to Anderson-Cottonwood Irrigation District Dam to eliminate short-term flow fluctuations (completed)

- Maintaining instream flows through coordinated operation of water facilities (ongoing)
- Improvements at Coleman National Fish Hatchery (partially complete)
- Measures to reduce acute toxicity caused by acid mine drainage and heavy metals (ongoing)
- Various fisheries improvements on Clear Creek (partially complete)
- Flow increases, fish screens, and revised gravel removal practices on Battle Creek (beginning summer 2006)
- Control of gravel mining, improvements of spawning areas, improvements of land management practices in the watershed, and protection and restoration of riparian vegetation along Cottonwood Creek

Sacramento River National Wildlife Refuge

The Sacramento River National Wildlife Refuge (SRNWR) is composed of many units between the cities of Red Bluff and Princeton. The SRNWR along the middle Sacramento River is part of the Sacramento National Wildlife Refuge Complex, consisting of five refuges and three wildlife management areas within the Sacramento Valley. Reaches and subreaches of the river are delineated based generally on transitions in fluvial geomorphic riverine conditions, although county boundaries were considered as well. The middle Sacramento River region between Red Bluff and Colusa includes three units within the Chico Landing Subreach that contain restoration project sites addressed in the Sacramento River–Chico Landing Subreach Habitat Restoration Draft EIR (CBDA 2005). In addition, three areas proposed for restoration in this area occur within the larger SRNWR units that were evaluated in the Environmental Assessment for Proposed Restoration Activities on the Sacramento River National Wildlife Refuge (USFWS 2001; CBDA 2005).

In June 2005, USFWS issued the Sacramento River National Wildlife Refuge Draft Comprehensive Conservation Plan and Environmental Assessment and Finding of No Significant Impact (USFWS 2005) to serve as an integrated management plan for land that it acquires and manages for inclusion in the SRNWR. The SRNWR final comprehensive conservation plan includes goals, objectives, and strategies to guide management of lands within the SRNWR. It also includes assessments of and establishes parameters for “compatible uses,” which are uses that are considered compatible with the primary purposes for which the area was established. Riparian habitat restoration projects are being implemented under cooperative agreements between USFWS and other entities such as TNC in accordance with the SRNWR final comprehensive conservation plan.

Sacramento River Preservation Trust

The Sacramento River Preservation Trust is a private, nonprofit organization active in environmental education and advocacy to preserve the natural environmental values of the Sacramento River. The trust has participated in various conservation and land acquisition projects, including securing lands for the SRNWR. The group is pursuing designation of a portion of the Sacramento River between Redding and Red Bluff as a national conservation area.

Sacramento River Watershed Program

The Sacramento River Watershed Program is an effort to bring stakeholders together to share information and work together to address water quality and other water-related issues within the Sacramento River watershed. The group is funded congressionally through the U.S. Environmental Protection Agency. The program's primary goal is "to ensure that current and potential uses of Sacramento River watershed resources are sustained, restored, and where possible, enhanced while promoting the long-term social and economic vitality of the region." The Sacramento River Watershed Program manages grants for the Sacramento River Toxic Pollutants Control Program; performs extensive water quality monitoring, data collection, and data management for the watershed; and is instrumental in the study and monitoring of toxic pollutants. Although the program does not implement restoration projects, it is a potential partner for coordinating research and monitoring through consensus-based collaborative partnerships and promoting mutual education among the stakeholders of the Sacramento River watershed.

Sacramento Watersheds Action Group

The Sacramento Watersheds Action Group is a nonprofit corporation that secures funding for, designs, and implements projects that provide watershed restoration, streambank and slope stabilization, erosion control, watershed analysis, and road removal. Sacramento Watersheds Action Group has successfully worked with local groups, agencies, and organizations to fund and complete restoration projects on the Sacramento River and tributaries downstream from Keswick Dam. Their projects include development of the Sulphur Creek Watershed Analysis and Action Plan, the Whiskeytown Lake Shoreline Erosion Control Project, the Sulphur Creek Crossing Restoration Project, and the Lower Sulphur Creek Realignment and Riparian Habitat Enhancement Project. Sacramento Watersheds Action Group is a potential local sponsor for watershed restoration actions in the study area.

Shasta Land Trust

The Shasta Land Trust is a regional, nonprofit organization dedicated to conserving open space, wildlife habitat, and agricultural land. The trust works with public agencies and private landowners and is funded primarily through membership dues and donations. It employs various voluntary programs to protect and conserve valuable lands using conservation easements, land donations, and property acquisitions. The trust is a potential local partner for restoration activities in the Shasta Dam-to-Red Bluff area.

The Nature Conservancy

TNC is a private, nonprofit organization involved in environmental restoration and conservation throughout the United States and the world. TNC approaches environmental restoration primarily through strategic land acquisition from willing sellers and obtaining conservation easements. Some of the lands are retained by TNC for active restoration, research, or monitoring activities, while others are turned over to government agencies such as USFWS or CDFW for long-term management. Lower in the Sacramento River basin, TNC has been instrumental in acquiring and restoring lands in the SRNWR and managing several properties along the Sacramento River. It also has pursued conservation easements on various properties at tributary confluences, including Cottonwood and Battle creeks.

The Trust for Public Land

The Trust for Public Land is a national, nonprofit organization involved in preserving lands with natural, historic, cultural, or recreational value, primarily through conservation real estate. The trust's Western Rivers Program has been involved in conservation efforts along the Sacramento River between Redding and Red Bluff (BLM's Sacramento River Bend Management Area), Battle Creek, Paynes Creek, Inks Creek, and Fenwood Ranch in Shasta County. The group promotes public ownership of conservation lands to ensure public access and enjoyment.

12.3 Environmental Consequences and Mitigation Measures

This section describes the methods for environmental evaluation, assumptions, and specific criteria that were used to determine significance for botanical resources and wetlands, and then discusses the effects of the project and proposes mitigation where necessary.

12.3.1 Methods and Assumptions

The following sections describe the methods, processes, procedures, and assumptions used to formulate and conduct the environmental impact analysis. Data for the following analysis were taken from modeling, existing reports on local and site-specific biology, and on-site assessments during field reviews.

CalSim Modeling

The SLWRI 2012 Version CalSim-II model, developed in 2012 for SLWRI, was used to aid in the evaluation of potential impacts of the project alternatives on water-related resources, including riparian habitats along the upper and lower Sacramento River and in the Delta. This computer modeling used historical data on California hydrology to represent the variety of weather and hydrologic patterns, including wet periods and droughts, under which water storage and conveyance facilities would be operated. Two scenarios (base cases) of demands for, and storage and conveyance of, water were used in model runs: 2005 facilities and demands ("existing conditions") and forecasted

2030 demands and reasonably foreseeable projects and facilities ("future conditions"). A model run was conducted for each of these base cases combined with each alternative, so that the effects of the No-Action Alternative and other alternatives could be evaluated relative to both existing and future conditions. CalSim-II is a useful tool for this type of comparative analysis where the model is run twice, once to represent a base condition (no action) and a second time with a specific change (action) to assess the change in the outcome due to the input change.

The hydrologic analysis conducted for this EIS used the SLWRI 2012 Version CalSim-II model to approximate system-wide changes in storage, flow, salinity, and reservoir system reoperation associated with the SLWRI alternatives. The historical flow record of October 1921 to September 2003, adjusted for the influences of land use changes and upstream flow regulation, is used to represent the possible range of water supply conditions. Major Central Valley rivers, reservoirs, and CVP/SWP facilities are represented by a network of arcs and nodes. CalSim-II uses a mass balance approach to route water through this network. Simulated flows are mean flows for the month; reservoir storage volumes correspond to end-of-month storage. Monthly flow results were also used to simulate mean daily flows. A more detailed description of the SLWRI 2012 Version CalSim-II model, the modeling methodology used to evaluate this project, and key assumptions are provided in the Modeling Appendix. Summaries of the analysis and modeling results are provided in Chapter 6, "Hydrology, Hydraulics, and Water Management."

Maximum vs. Likely Area of Impact in Relocation Areas

The relocation areas identified by Reclamation in the 2013 Draft EIS were based on preliminary information, as planning and related engineering designs were incomplete at that time. Habitat impacts disclosed for the relocation areas in the June 2013 Draft EIS assumed complete impact (i.e., 100 percent loss) within all the relocation areas. Since that time, Reclamation revised the relocation area boundaries by conducting additional planning and design that in many cases reduced the size of the relocation areas. Additionally, Reclamation designed infrastructure and other activities within the revised relocation areas to avoid wetlands and other sensitive resources, and reduce habitat impacts to the extent feasible.

Since final relocation area planning and designs are incomplete, each relocation area contains a "maximum" and "likely" impact area. The maximum area of impact is defined as the maximum area potentially affected by project activities occurring within the relocation areas, while the likely impact area represents Reclamation's best estimate of the actual impact (i.e., "most likely"). For the purposes of this Final EIS, habitat impacts are based on the assumption of complete loss within the likely impact areas. Table 12-12 shows a comparison of the maximum and likely CWHR habitats in the relocation areas.

Table 12-12. Summary of "Maximum" and "Likely" Plant Communities in the Relocation Areas

Plant Communities	Area (Acres)													
	Main Body		Big Backbone Arm		Sacramento Arm		McCloud Arm		Squaw Creek Arm		Pit Arm		Total	
	Max	Likely	Max	Likely	Max	Likely	Max	Likely	Max	Likely	Max	Likely	Max	Likely
Barren[1]	22.32	12.46	0.00		74.17	12.51	29.66	5.40	11.53	0.00	12.77	2.96	150.46	33.32
Birch-leaf mountain-mahogany chaparral	0.00	0.00	0.00		0.00	0.00	0.41	0.00	0.00	0.00	0.00	0.00	0.41	0.00
Black willow thicket	0.00	0.00	0.00		0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00
Blue oak woodland	0.00	0.00	0.00		0.00	0.00	3.68	0.00	0.00	0.00	0.93	0.00	4.61	0.00
Brewer oak scrub	5.46	2.69	0.00		13.22	0.60	8.40	2.35	0.00	0.00	0.12	0.12	27.20	5.76
Buck brush chaparral	0.00	0.00	0.00		0.77	0.00	1.45	0.03	0.00	0.00	0.04	0.04	2.26	0.06
California annual grassland	4.76	0.40	0.00		20.31	4.95	9.75	0.53	0.84	0.70	0.23	0.01	35.89	6.59
California ash chaparral	0.00	0.00	0.00		0.00	0.00	0.68	0.00	0.00	0.00	0.00	0.00	0.68	0.00
California black oak forest	35.03	18.81	0.00		131.78	20.44	77.04	18.70	1.29	0.00	0.04	0.04	245.17	57.99
California buckeye groves[2]	0.00	0.00	0.00		0.00	0.00	1.58	0.003	0.00	0.00	0.00	0.00	1.58	0.003
California yerba santa scrub	0.09	0.02	0.00		0.00	0.00	0.00	0.00	0.00	0.00	2.75	0.74	2.83	0.76
Canyon live oak forest	1.06	0.92	0.00		8.10	1.25	77.26	6.04	4.98	0.24	5.60	5.60	96.99	14.05
Deer brush chaparral	0.18	0.04	0.00		0.00	0.00	0.57	0.00	0.00	0.00	0.40	0.40	1.15	0.43
Ghost pine woodland	105.48	24.52	0.00		41.27	6.81	29.95	1.73	13.48	1.13	11.94	2.38	202.11	36.56
Himalayan blackberry brambles	0.15	0.03	0.00		0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.21	0.03
Interior live oak chaparral	0.00	0.00	0.00		0.60	0.00	0.00	0.00	0.00	0.00	22.70	2.47	23.29	2.47
Interior live oak woodland	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.05	0.05	0.05
Knobcone pine forest	0.11	0.05	0.00		40.64	4.91	9.65	2.23	1.94	0.23	13.96	0.99	66.30	8.42
Lacustrine[1]	0.00	0.00	0.00		0.00	0.00	0.001	0.001	0.00	0.00	0.00	0.00	0.001	0.001

Table 12-12. Summary of "Maximum" and "Likely" Plant Communities in the Relocation Areas (contd.)

Plant Communities	Area (Acres)													
	Main Body		Big Backbone Arm		Sacramento Arm		McCloud Arm		Squaw Creek Arm		Pit Arm		Total	
	Max	Likely	Max	Likely	Max	Likely	Max	Likely	Max	Likely	Max	Likely	Max	Likely
Mixed willow	0.08	0.02	0.00		0.73	0.00	0.00	0.00	0.06	0.00	0.01	0.01	0.87	0.03
Oregon ash groves	0.00	0.00	0.00		0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.33	0.00
Oregon white oak woodland	0.00	0.00	0.00		0.00	0.00	5.72	0.45	0.07	0.00	0.00	0.00	5.72	0.45
Pale spike rush marshes	0.00	0.00	0.00		6.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.51	0.00
Ponderosa pine–Douglas fir forest	0.00	0.00	0.00		13.06	1.35	106.07	8.25	15.62	1.50	11.80	6.43	146.55	17.54
Ponderosa pine forest	156.56	79.71	0.00		458.50	107.60	347.64	67.35	43.08	16.04	35.97	1.20	1041.75	271.91
Riverine[1]	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sandbar willow thickets	0.00	0.00	0.00		0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.09	0.00
Spicebush thickets	0.00	0.00	0.00		0.00	0.00	0.64	0.00	0.00	0.00	0.00	0.00	0.64	0.00
Urban[1]	20.65	15.64	0.00		227.46	217.05	0.48	0.27	0.00	0.00	0.57	0.56	249.16	233.52
Valley oak woodland	0.00	0.00	0.00		1.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.06	0.00
White alder groves	0.00	0.00	0.00		0.23	0.03	1.90	0.25	0.17	0.04	0.00	0.00	2.31	0.32
White leaf manzanita chaparral	7.28	0.67	0.00		41.41	3.37	14.88	1.91	4.38	1.68	0.00	0.00	67.94	7.64
Total	359.20	155.98	0.00		1,079.84	380.88	727.92	115.50	97.44	21.56	119.83	24.00	2,387.23	697.91

Note:
[1] CWHR Wildlife Habitat Type; no corresponding plant series type include in *A Manual of California Vegetation* (Sawyer and Keeler-Way 1995).

Key:
Max = maximum

Vegetation and Habitat Types

The impact mechanisms of construction-related activities are evaluated in the sections addressing Shasta Lake and its vicinity. Besides construction-related activities, the project could potentially affect vegetation and habitat types through any of the following impact mechanisms:

- Increased inundated width of the river during the active growing season
- Reduced frequency and/or magnitude of peak flows
- Altered geomorphic processes (e.g., meander, channel avulsion) along rivers
- Altered availability of groundwater
- Altered rates of stage decline during seed dispersal or germination establishment

For each vegetation type, environmental effects potentially resulting from each of these impact mechanisms were assessed. This assessment was based on a review of the results of CalSim simulations of mean monthly flows, aerial photographs, background information on the upper Sacramento River and adjacent uplands, and scientific literature on the ecology of each vegetation type. Results of hydraulic modeling of the project’s potential effects on peak flows and analyses of the project’s potential effects on geomorphic processes along the Sacramento River were not available to support this analysis.

In addition to these impact mechanisms, increased water supplies or increased supply reliability also could reduce a limitation on urban growth and development or on other activities that could affect vegetation in the primary and extended study areas, resulting in potentially significant impacts. The effects of this growth would be analyzed in general plan EIRs and in project-level CEQA compliance documents for the local jurisdictions in which the growth would occur. Mitigation of these impacts would be the responsibility of these local jurisdictions, and not Reclamation. The expected increase in water deliveries relative to the entire CVP and SWP would be small, however, and assuming increased deliveries could be provided to any number of geographic areas within the CVP and SWP service areas (and in part would substitute for ongoing groundwater pumping), the project’s impact on urban growth and development that could affect vegetation would be minor.

Similarly, projects potentially affecting streambeds, wetlands, and listed species would require permits from the CDFW, USACE, and USFWS, respectively; impacts on these resources would be avoided, minimized, and/or mitigated during those agency consultations.

Because the extent, location, and timing of induced growth are currently highly uncertain, and in the future the impacts of this growth would be analyzed and mitigated during land use planning and environmental review for specific projects, growth-inducing effects on vegetation and habitat types are not discussed further in this section. However, additional discussion of growth-inducing effects specific to the alternative actions is provided in Chapter 26, "Other Required Disclosures," of this EIS.

For the purposes of the impact analysis for the loss of general habitats in the Shasta Lake and vicinity portion of the primary study area, California Wildlife Habitat Relationship (CWHR) types are used to describe the affected habitats. Table 12-13 provides a crosswalk between MCV and CWHR habitat types.

Special-Status Species

The project could affect special-status plant species through the same impact mechanisms potentially affecting vegetation and habitat types, and also by altering the structure and species composition of vegetative communities, particularly within river corridors.

Potential impacts resulting from these impact mechanisms were assessed for special-status plant species that may occur in the project area. This assessment was based on the potential impacts on vegetation and habitat types for each alternative and on available information about the distribution, ecology, and reproductive biology of each special-status species.

Assumptions

The following assumptions have been made for the purposes of the impact analysis:

- Activity areas (construction areas for infrastructure and relocation areas) would be completely cleared.
- Mechanized equipment would be used for discrete areas where total clearing would occur.
- All trees would be removed along other areas of the lake, including those that could be considered a hazard in coves used by houseboats for moorage; other vegetation would be left.

Trees would be removed using helicopters and barges.

Table 12-13. Comparison Between MCV Vegetation Types and CWHR Habitat Types

MCV Type	CWHR Type
Barren	Barren
Birch-leaf mountain-mahogany chaparral	Mixed chaparral
Black willow thicket	Montane riparian
Blue oak woodland	Blue oak woodland
Brewer oak scrub	Mixed chaparral
Buck brush chaparral	Mixed chaparral
California annual grassland	Annual grassland
California ash chaparral	Mixed chaparral
California black oak forest	Montane hardwood
California buckeye groves	Mixed chaparral
California yerba santa scrub	Mixed chaparral
Canyon live oak forest	Montane hardwood
Deer brush chaparral	Mixed chaparral
Douglas-fir	Douglas-fir
Fremont cottonwood	Montane riparian
Ghost pine woodland	Montane hardwood–conifer, Blue oak–foothill pine
Himalayan blackberry brambles	Montane riparian
Interior live oak chaparral	Mixed chaparral
Interior live oak woodland	Montane hardwood
Knobcone pine forest	Closed-cone pine–cypress
Lacustrine	Lacustrine
Mixed willow	Montane riparian
Oregon ash groves	Montane riparian
Oregon white oak woodland	Montane hardwood
Ponderosa pine–Douglas-fir forest	Montane hardwood–conifer, Klamath mixed conifer
Ponderosa pine forest	Ponderosa pine
Red osier thickets	Montane riparian
Riverine	Riverine
Sandbar willow thickets	Montane riparian
Spicebush thickets	Montane riparian
Valley oak woodland	Montane hardwood
Urban	Urban
White alder groves	Montane riparian
White leaf manzanita chaparral	Mixed chaparral

Key:
CWHR = California Wildlife Habitat Relationship
MCV = A Manual of California Vegetation

12.3.2 Criteria for Determining Significance of Effects

An environmental document prepared to comply with NEPA must consider the context and intensity of the environmental effects that would be caused by, or result from, the proposed action. Under NEPA, the significance of an effect is used solely to determine whether an EIS must be prepared. An environmental document prepared to comply with CEQA must identify the potentially significant environmental effects of a proposed project. A "[s]ignificant effect on the environment" means a substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by the project" (State CEQA Guidelines, Section 15382). CEQA also requires that the environmental document propose feasible measures to avoid or substantially reduce significant environmental effects (State CEQA Guidelines, Section 15126.4(a)).

Vegetation and Habitat Types

The following significance criteria were developed based on guidance provided by the State CEQA Guidelines, and consider the context and intensity of the environmental effects as required under NEPA. Impacts of an alternative on vegetation and habitat types would be significant if project implementation would do any of the following:

- Result in a substantial adverse effect on any riparian vegetation or habitat, oak woodlands or savannas, or other sensitive natural community identified in local or regional plans, policies, regulations, or by CDFW or USFWS
- Conflict with a local policy or ordinance that protects vegetation resources, such as a tree preservation policy or ordinance
- Conflict with or violate the provisions of an adopted habitat conservation plan, natural community conservation plan, or other approved local, regional, State, or Federal habitat conservation plan relating to the protection of plant resources
- Result in the potential for spread of nonnative and invasive plant species

Special-Status Species

Impacts of an alternative on special-status species would be significant if project implementation would do any of the following:

- Result in a substantial adverse effect, either directly or through habitat modifications, on any plant species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations or by CDFW or USFWS

- Have the potential to substantially reduce the number or restrict the range of an endangered or threatened plant species or a plant species that is a candidate for State listing or proposed for Federal listing as endangered or threatened

- Have the potential for substantial reductions in the habitat of an endangered or threatened plant species or a plant species that is a candidate for State listing or proposed for Federal listing as endangered or threatened

- Substantially reduce the number or restrict the range of an endangered, rare, or threatened species, cause a native plant population to drop below self-sustaining levels, or threaten to eliminate a plant community

- Have the potential to cause a native plant population to drop below self-sustaining levels

Wetlands

Impacts of an alternative on wetlands would be significant if project implementation would do any of the following:

- Have a substantial adverse effect on Federally protected wetlands as defined by Section 404 of the CWA (including, but not limited to, marsh, vernal pool, etc.) through direct removal, filling, hydrological interruption, flooding, or other means

- Conflict with any State or local policies or ordinances protecting wetland and/or riparian resources

- Conflict with or violate the provisions of an adopted habitat conservation plan, natural community conservation plan, or other approved local, regional, State, or Federal habitat conservation plan relating to the protection of wetland resources

Shasta-Trinity National Forest Land and Resource Management Plan

In addition to the above significance criteria, the STNF LRMP (USFS 1995) contains forest goals, standards, and guidelines designed to guide the management of the biological resources within the STNF, located in the Shasta Lake and vicinity portion of the primary study area. To comply with NEPA, this assessment of impacts evaluates the project's compliance with the STNF LRMP forest goals, standards, and guidelines listed in the "Regulatory Framework" section listed above. Mitigation measures are provided (as needed) to move project actions toward compliance with the STNF LRMP.

12.3.3 Topics Eliminated from Further Consideration

No topics related to botanical resources and wetlands that are included in the significance criteria listed above were eliminated from further consideration. All relevant topics are analyzed below.

12.3.4 Direct and Indirect Effects

This section identifies how specific vegetation types could be affected by the project. The project could affect vegetation by doing any of the following:

- Causing construction-related effects at Shasta Dam and around Shasta Lake
- Altering flow regimes downstream from Shasta Lake and downstream from other reservoirs with altered operations
- Increasing water supply reliability that, in turn, could contribute to growth or changes in agricultural land uses in the CVP and SWP service areas

By altering storage and reservoir operations, the project would change flow regimes in downstream waterways. In turn, these alterations to the flow regime could affect vegetation, particularly riparian and wetland vegetation along several waterways.

No-Action Alternative

Under the No-Action Alternative, the Federal Government would take reasonably foreseeable actions, as defined in Chapter 2, “Alternatives,” but would take no additional action toward implementing a specific plan to help increase anadromous fish survival in the upper Sacramento River, nor help address the growing water reliability issues in California. Shasta Dam would not be modified, and the CVP would continue operating similar to the existing condition. Changes in regulatory conditions and water supply demands would result in differences in flows on the Sacramento River and at the Delta between existing and future conditions. Possible changes include the following:

- Firm Level 2 Federal refuge deliveries
- SWP deliveries based on full Table A amounts
- Full implementation of the Grassland Bypass Project
- Implementation of salinity management actions similar to the Vernalis Adaptive Management Plan
- Implementation of the South Bay Aqueduct Improvement and Enlargement Project

- Increased San Joaquin River diversions for water users in the Stockton Metropolitan Area after completion of the Delta Water Supply Project
- Increased Sacramento River diversions by Freeport Regional Water Project agencies
- Operation of RBPP with gates out year round
- San Joaquin River Restoration Program Full Restoration Flows

This alternative is used as a basis of comparison for future condition comparisons.

Shasta Lake and Vicinity

Impact Bot-1 (No-Action): Loss of Federally or State Listed Plant Species Habitat for Federally or State-listed plant species does not occur at Shasta Lake or in the vicinity. No species are known or expected to occur. Therefore, no impact would occur. Mitigation is not required for the No-Action Alternative.

Impact Bot-2 (No-Action): Loss of MSCS Covered Species Species covered by the MSCS would not be lost as a result of inundation, vegetation removal, or construction activities. Therefore, no impact would occur. Mitigation is not required for the No-Action Alternative.

Impact Bot-3 (No-Action): Loss of USFS Sensitive, BLM Sensitive, or CRPR Species USFS sensitive, BLM sensitive, or CRPR listed species would not be lost as a result of inundation, vegetation removal, or construction activities. Therefore, no impact would occur. Mitigation is not required for the No-Action Alternative.

Impact Bot-4 (No-Action): Loss of Jurisdictional Waters Waters of the United States would not be lost as a result of inundation, vegetation removal, or construction activities. Therefore, no impact would occur. Mitigation is not required for the No-Action Alternative.

Impact Bot-5 (No-Action): Loss of General Vegetation Habitats General vegetation habitats would not be lost as a result of inundation, vegetation removal, or construction activities. Therefore, no impact would occur. Mitigation is not required for the No-Action Alternative.

Impact Bot-6 (No-Action): Spread of Noxious and Invasive Weeds Noxious and invasive weeds would not be spread as a result of inundation, vegetation removal, or construction activities. Therefore, no impact would occur. Mitigation is not required for the No-Action Alternative.

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact Bot-7 (No-Action): Altered Structure and Species Composition and Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from

Altered Flow Regimes Altered flow regimes associated with the No-Action Alternative could alter the structure and species composition or cause the loss of riparian, wetland, and oak communities along the upper Sacramento River, and habitat for special-status plant species. Vernal pool plant communities and associated special-status species likely would not be affected. Effects on oak communities and upland habitats for special-status plants may not all be adverse. Adverse effects on riparian and wetland communities and associated special-status plants would be small, and beneficial effects are also anticipated to result from other management and restoration actions. Thus, this impact would be less than significant.

Although Shasta Dam would not be altered under the No-Action Alternative, CVP and SWP water storage, conveyance, and deliveries would change because of several reasonably foreseeable actions that would occur with or without enlarging Shasta Dam. As a consequence of these actions, the flow regime of the upper Sacramento River would change between 2005 and 2030. The CalSim-II modeling results that simulate these changes are provided in the *Hydrology, Hydraulics, and Water Management Technical Report*. CalSim-II mean monthly results used to simulate mean daily values also indicate the relative magnitude of changes to the flow regime.

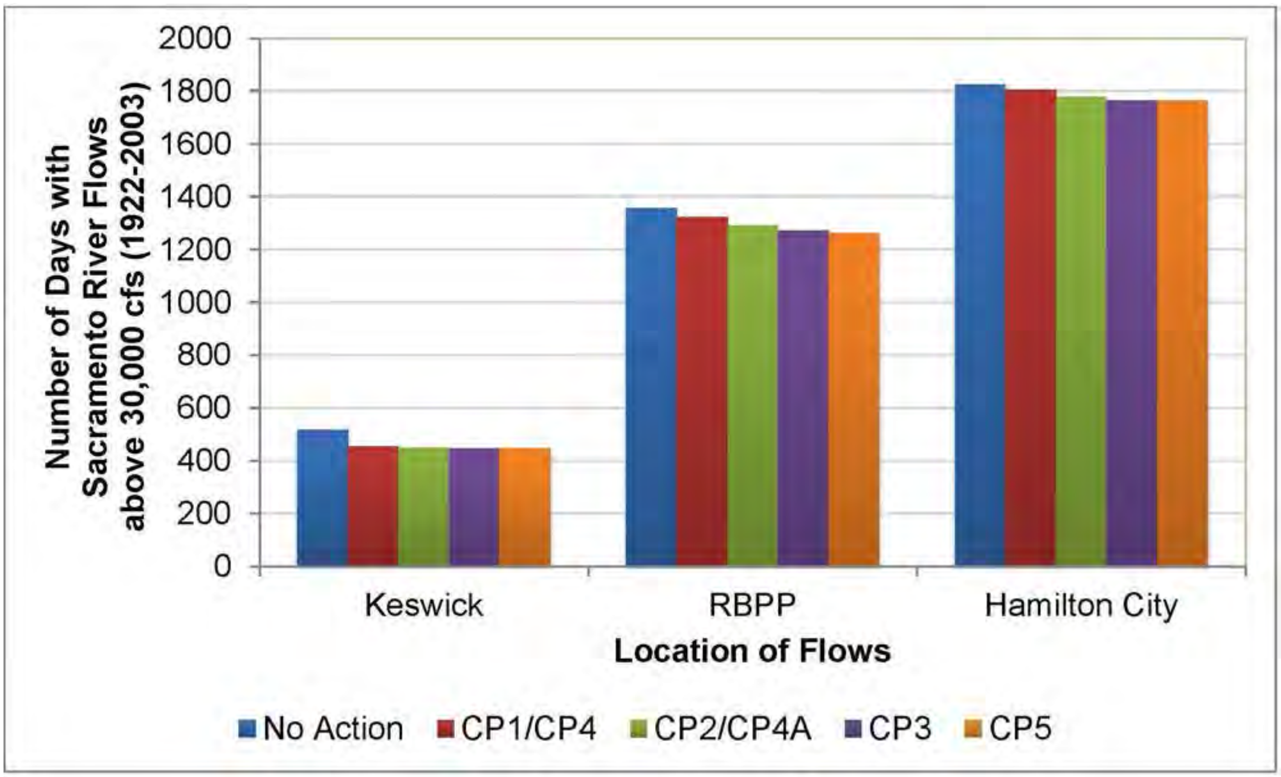
The rates of geomorphic processes strongly affect the extent of different riparian communities, and these rates are strongly related to flow regime. For example, bank erosion and the average rate of meander migration are closely related to the cumulative portion of flow above a threshold volume. On portions of the Sacramento River, this threshold may be around 30,000 cfs (Larsen, Fremier, and Greco 2006; Stillwater Sciences 2007), which is well below the bankfull discharge but well above flows during spring and summer. However, other important thresholds for bank erosion and channel avulsion along the Sacramento River have been estimated within the range from 10,000 to 80,000 cfs (Stillwater Sciences 2007). (For additional discussion of the relationship of geomorphic processes to flow along the Sacramento River, see the *Fisheries and Aquatic Ecosystem Technical Report*.)

The number of days with Sacramento River flows above 30,000 cfs (1922-2013) are summarized on Figure 12-6. Overall, these modeling results suggest there would be only very small changes in flows greater than 30,000 cfs. Flows of this magnitude strongly affect bank erosion and meander migration, and are related to other geomorphic processes affecting the extent of different riparian communities. These relationships are described in greater detail under CP1.

This change might not be sufficient to cause significant effects on riparian and wetland communities, or on associated special-status species.

In addition to causing small changes in flow regime, the No-Action Alternative would continue to alter the structure and species composition of riparian and wetland vegetation resulting from continued operation of Shasta Dam. Before the construction of Shasta Dam, river flow and stage would decrease gradually during the period of cottonwood and willow seed dispersal. In many years, this flow pattern would facilitate establishment of these early-successional species along the Sacramento River throughout the primary study area.

Operation of Shasta Dam has increased flow volumes from mid-spring to early summer. Consequently, in most years, operation of the dam precludes or substantially reduces opportunities for establishment of cottonwoods and opportunities for willow establishment. As a result of this (and other alterations to the flow regime of the Sacramento River), the structure and species composition of riparian vegetation has been changing within the primary study area (Fremier 2003, Roberts et al. 2002). The extent of early-successional riparian communities (e.g., cottonwood forest) has been decreasing while the extent of mid-successional communities (e.g., mixed riparian forest) has been increasing. Such changes would continue under the No-Action Alternative for several decades, but would diminish with time.



Key:
cfs = cubic feet per second
RBPP = Red Bluff Pumping Plant

Figure 12-6. Number of Days with Sacramento River Flows above 30,000 cfs (1922-2013)

However, under the No-Action Alternative a number of management and restoration plans and programs would be implemented. These actions are described in Section 12.2, "Regulatory Framework," of this EIS. These actions would cause beneficial effects that would likely be of similar magnitude to the anticipated adverse effects of small changes in flow regime and of continued effects from past actions, and thus would largely offset those adverse effects.

For the reasons described above, this impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Impact Bot-8 (No-Action): Conflict with Approved Local or Regional Plans with Objectives of Riparian Habitat Protection or Watershed Management Numerous local and regional plans promote the conservation of riparian vegetation and associated habitats along the upper Sacramento River. Expected future effects of the No-Action Alternative on riparian communities have largely been considered in the existing plans. The No-Action Alternative would not conflict with approved local or regional plans. This impact would be less than significant.

Numerous local and regional plans address and promote the conservation of riparian vegetation and associated habitats along the upper Sacramento River in the primary study area. These plans, which are discussed in more detail in the "Regulatory Setting" section of this EIS, include the Sacramento River Conservation Area Program, which promotes the conservation and the restoration of riparian habitat. Under the No-Action Alternative, adverse effects would result from the continued consequences of past actions (e.g., construction of Shasta Dam and the introduction of nonnative species) and from the effects of reasonably foreseeable actions. Most adverse effects that are the continued consequences of past actions have been considered in the development of existing local and regional plans. In addition, foreseeable water resources and levee actions are expected to be consistent with local and regional plans, and anticipated adverse effects are likely to be fully mitigated and not conflict with a local or regional plan. Therefore, the No-Action Alternative would not conflict with approved local or regional plans with objectives of riparian habitat protection or watershed management. This impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Impact Bot-9 (No-Action): Disturbance or Removal of Designated Critical Habitat for Special-Status Species Designated critical habitat for vernal pool species in the upper Sacramento River area is not expected to be adversely affected. This impact would be less than significant.

Designated critical habitat for four vernal pool special-status plant species exists in the upper Sacramento River portion of the primary study area: slender orcutt grass, Hoover's spurge, hairy orcutt grass, and Greene's tuctoria. Critical habitat for these species in the primary study area is confined to vernal pool communities (USFWS 2006). Vernal pools are generally not present within the active floodplain. However, if vernal pool habitats for these special-status species are present in the active floodplain of the upper Sacramento River, they could be affected by the small reduction in the frequency and magnitude of overbank flows. It is not known if this would be an adverse or beneficial effect. Because this effect of the No-Action Alternative is somewhat speculative and not necessarily adverse, this impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Impact Bot-10 (No-Action): Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Induced Growth Although Shasta Dam would not be altered, water storage, conveyance, and deliveries to water districts would likely increase because of reasonably foreseeable projects. However, environmental regulations would continue to provide protection for botanical resources and wetlands, and the effects of future growth would be analyzed and mitigated during land use planning and environmental review for specific projects. Therefore, this impact would be less than significant.

Although Shasta Dam would not be altered under the No-Action Alternative, CVP and SWP water storage, conveyance, and deliveries would change because of several reasonably foreseeable projects that would occur with or without enlarging Shasta Dam. Consequently, deliveries to water districts along the upper Sacramento River in the primary study area would likely increase between now and 2030, and this could reduce any limitation on urban growth and development. However, environmental regulations would continue to protect wetlands, riparian habitats, other sensitive botanical communities, and special-status plant species, and the effects of future growth would be analyzed and mitigated during land use planning and environmental review for specific projects. Furthermore, CVP water delivered in this area would primarily be for agricultural purposes, and agricultural acreages are not expected to expand. For the reasons described above, this impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Lower Sacramento River and Delta

Impact Bot-11 (No-Action): Loss of Sensitive Natural Communities or Habitats Resulting from Implementing the Gravel Augmentation Program or Restoring Riparian, Floodplain, and Side Channel Habitats The proposed gravel augmentation program and riparian, floodplain, and side channel restoration activities would not be implemented under the No-Action Alternative. Therefore, no impact would occur. Mitigation is not required for the No-Action Alternative.

Impact Bot-12 (No-Action): Loss of Special-Status Plants Resulting from Implementing the Gravel Augmentation Program or Restoring Riparian, Floodplain, and Side Channel Habitats The proposed gravel augmentation program and riparian, floodplain, and side channel restoration activities would not be implemented under the No-Action Alternative. Therefore, no impact would occur. Mitigation is not required for the No-Action Alternative.

Impact Bot-13 (No-Action): Spread of Noxious and Invasive Weeds Resulting from Implementing the Gravel Augmentation Program or Restoring Riparian, *Floodplain, and Side Channel Habitats* The proposed gravel augmentation program and riparian, floodplain, and side channel restoration activities would not be implemented under the No-Action Alternative. Therefore, no impact would occur. Mitigation is not required for the No-Action Alternative.

Impact Bot-14 (No-Action): Altered Structure and Species Composition and Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Altered Flow Regimes on the Lower Sacramento River Altered flow regimes associated with the No-Action Alternative could alter the structure and species composition or cause the loss of riparian, wetland, and oak communities along the lower Sacramento River and in the Delta, and of habitat for special-status plant species. Vernal pool plant communities and associated special-status plant species likely would not be affected. Effects on oak communities and upland habitats for special-status plants may not all be adverse. Adverse effects on riparian and wetland communities and associated special-status plants would be small, and beneficial effects are also anticipated to result from management and restoration actions. Thus, this impact would be less than significant.

Although Shasta Dam would not be altered under the No-Action Alternative, CVP and SWP water storage, conveyance, and deliveries would change because of several reasonably foreseeable actions that would occur with or without enlarging Shasta Dam. As a consequence of these actions, the flow regime of the lower Sacramento River could change between 2005 and 2030. The CalSim-II modeling results that simulate these changes are provided in the *Hydrology, Hydraulics, and Water Management Technical Report*. CalSim-II results temporally downscaled to mean daily values also indicate the relative magnitude of changes to the flow regime. The simulated change in mean daily discharges greater than 30,000 cfs below RBPP and Hamilton City are summarized on Figure 12-6. (These locations are shown on Figure 12-7.) Flows of this magnitude strongly affect bank erosion and meander migration, and are related to other geomorphic processes affecting the extent of different riparian communities. (These relationships are described in greater detail under CP1.) Overall, these modeling results suggest only a very small change in flows greater than 30,000 cfs along the uppermost portion of the lower Sacramento River. This change might not be sufficient to cause significant effects on riparian and wetland communities, or on associated special-status species.

However, besides causing additional, very small changes in flow regime, the No-Action Alternative would continue to alter the structure and species composition of riparian and wetland vegetation along the lower Sacramento River resulting from the continued operation of Shasta Dam. Before the construction of Shasta Dam, flow volume would decrease gradually during the period of cottonwood and willow seed dispersal. In many years, this flow pattern would facilitate establishment of these early- successional species along the Sacramento River throughout the extended study area. As described for the upper Sacramento River above, along the lower Sacramento River, the extent of early-successional riparian communities would continue decreasing while the extent of mid-successional communities would continue increasing under the No-Action Alternative.

However, under the No-Action Alternative, a number of management and restoration plans and programs carried out by a large number of agencies would be implemented. These actions are described in the "Regulatory Setting" section of this EIS. These actions would cause beneficial effects that would likely be of similar magnitude as the anticipated adverse effects of small changes in flow regime and of continued effects from past actions, and thus would largely offset those adverse effects.

For the reasons described above, this impact would be less than significant. Mitigation is not required for the No-Action Alternative.

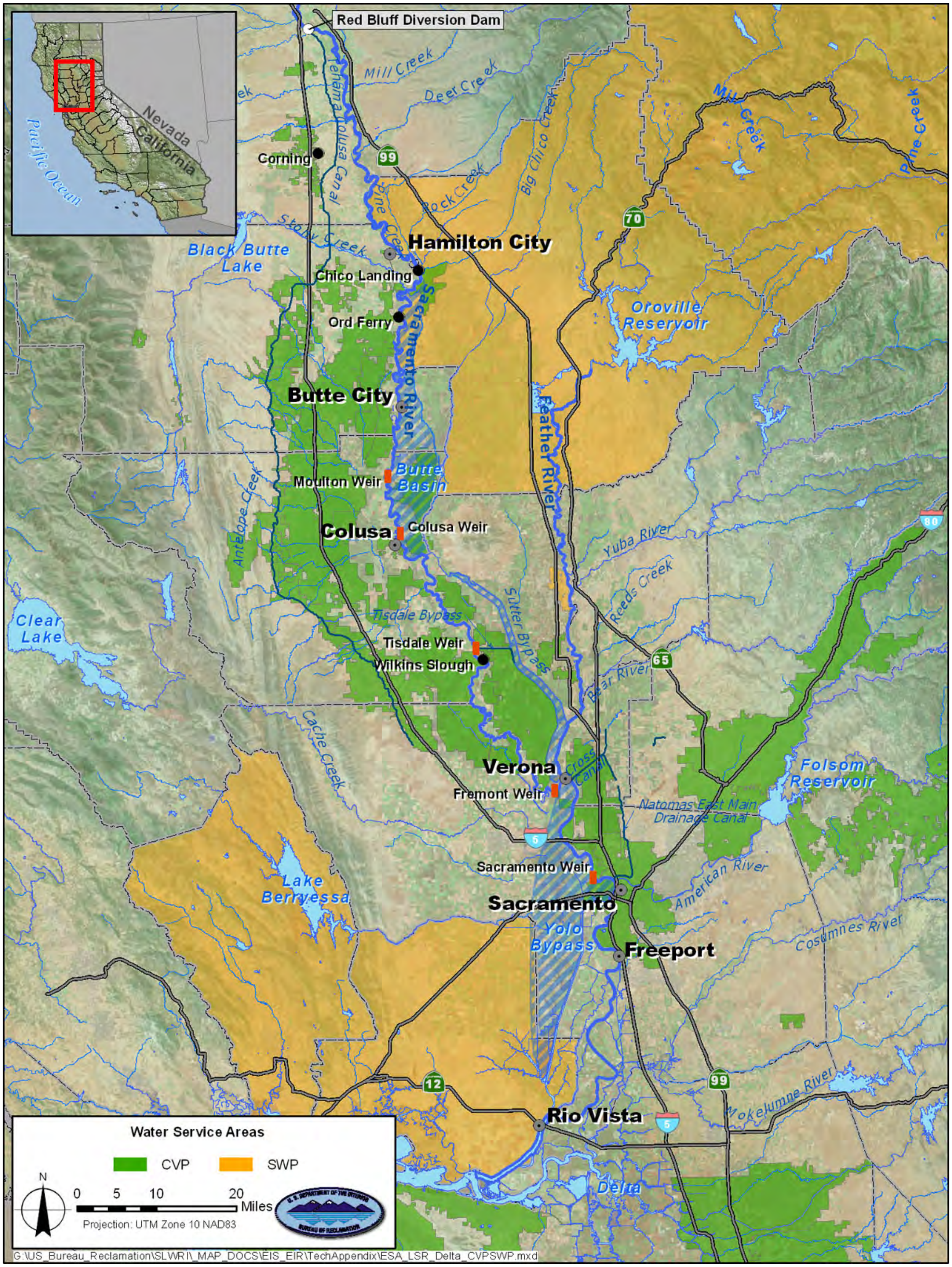


Figure 12-7. Locations Along the Lower Sacramento River

Impact Bot-15 (No-Action): Conflict with Approved Local or Regional Plans with Objectives of Riparian Habitat Protection or Watershed Management along the Lower Sacramento River Adopted local and regional plans address and promote the conservation of riparian vegetation and associated habitats along the lower Sacramento River. In the development of regional and local plans, most ongoing adverse effects of past actions were considered, but not all effects of reasonably foreseeable actions. Unmitigated effects from these actions could be sufficient to conflict with these plans. Therefore, the No-Action Alternative could conflict with approved local or regional plans. This impact would be potentially significant.

Adopted local and regional plans address and promote the conservation of riparian vegetation and associated habitats along the lower Sacramento River and in the Delta in the extended study area. These plans, which are discussed in more detail in the "Regulatory Framework" section of this EIS, include the Sacramento River Conservation Area Program and the CALFED Ecosystem Restoration Program, both of which promote the conservation and the restoration of riparian habitat. Under the No-Action Alternative, adverse effects would result from the continued consequences of past actions (e.g., construction of Shasta Dam and the introduction of nonnative species) and from the effects of foreseeable actions. Most adverse effects that are the continued consequences of past actions have been considered in the development of existing local and regional plans. However, the adverse effects of all foreseeable water resource and levee actions were not considered in the development of local and regional plans, and these adverse effects are not likely to be completely avoided or fully mitigated. The unmitigated effects of these actions could be sufficient overall to conflict with a local or regional plan. Therefore, the No-Action Alternative could conflict with approved local or regional plans with objectives of riparian habitat protection or watershed management. This impact would be potentially significant. Mitigation is not required for the No-Action Alternative.

Impact Bot-16 (No-Action): Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Induced Growth along the Lower Sacramento River and in the Delta Although Shasta Dam would not be altered, water storage, conveyance, and deliveries to water districts would likely increase because of reasonably foreseeable actions. However, environmental regulations would continue to provide protection for botanical resources and wetlands, and the effects of future growth would be analyzed and mitigated during land use planning and environmental review for site-specific projects. Therefore, this impact would be less than significant.

Although Shasta Dam would not be altered under the No-Action Alternative, CVP and SWP water storage, conveyance, and deliveries would likely increase because of several reasonably foreseeable actions that would occur with or without enlarging Shasta Dam. Thus, deliveries to water districts in the extended study area along the lower Sacramento River and in the Delta would likely increase between now and 2030, and this could reduce a limitation on urban growth and development. However, environmental regulations would continue to protect wetlands, riparian habitats, other sensitive botanical communities, and special-status plant species, and the effects of future growth would be analyzed and mitigated during land use planning and environmental review for site-specific projects. Therefore, this impact would be less than significant. Mitigation is not required for the No-Action Alternative.

CVP/SWP Service Areas

Impact Bot-17 (No-Action): Altered Structure and Species Composition and Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Altered Flow Regimes in the CVP/SWP Service Areas Altered flow regimes associated with the No-Action Alternative could alter the structure and species composition or cause the loss of riparian, wetland, and oak communities in the CVP and SWP service areas, and of habitat for special-status plant species. However, alteration of flow regimes below CVP and SWP reservoirs would be less than below Shasta Dam along the Sacramento River, and may not be sufficient to alter the distribution of plant communities, or the extent or quality of associated special-status species habitat. Therefore, this impact would be less than significant.

Altered flow regimes associated with the No-Action Alternative could alter the structure and species composition or cause the loss of riparian, wetland, and oak communities, and of habitat for special-status plant species. Vernal pool plant communities and associated special-status plant species likely would not be affected by the altered flow regime. Effects on oak communities and upland habitats for special-status plants would be somewhat speculative and may not all be adverse; thus, on oak communities and special-status plants of upland habitats, this impact would be less than significant. Although riparian and wetland communities could be affected, alteration of flow regimes below CVP and SWP reservoirs in the extended study area would be less than below Shasta Dam along the upper and lower Sacramento River. Below CVP and SWP reservoirs, these alterations may not be sufficient to alter the extent of early-successional riparian and wetland communities, or the extent or quality of associated special-status species habitat. Therefore, this impact would be less than significant below CVP and SWP reservoirs in the extended study area. Mitigation is not required for the No-Action Alternative.

Impact Bot-18 (No-Action): Conflict with Approved Local or Regional Plans with Objectives of Riparian Habitat Protection or Watershed Management in the CVP/SWP Service Areas The No-Action Alternative would not have substantial effects on riparian vegetation and habitats, and thus, would not conflict with existing local and regional plans in the CVP and SWP service areas. This impact would be less than significant.

Adopted local and regional plans address and promote the conservation of riparian vegetation and associated habitats along rivers below reservoirs in the CVP and SWP service areas. However, implementation of the No-Action

Alternative would not have substantial effects on riparian vegetation and habitats. Therefore, implementation of this alternative would not conflict with existing local and regional plans focused on preserving riparian habitats. Thus, this impact in the CVP and SWP service areas would be less than significant. Mitigation is not required for the No-Action Alternative.

Impact Bot-19 (No-Action): Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Induced Growth in the CVP/SWP Service Areas Although Shasta Dam would not be altered, water storage, conveyance, and deliveries to the CVP and SWP service areas would likely increase because of reasonably foreseeable actions. However, environmental regulations would continue to protect botanical resources and wetlands, and the effects of future growth would be analyzed and mitigated during land use planning and environmental review for specific projects. Therefore, this impact would be less than significant.

Although Shasta Dam would not be altered under the No-Action Alternative, CVP and SWP water storage, conveyance, and deliveries to the CVP and SWP service areas would likely increase because of several reasonably foreseeable actions that would occur with or without enlarging Shasta Dam. Thus, CVP and SWP deliveries would likely increase between now and 2030, and this could reduce any limitation on growth. However, environmental regulations would continue to protect wetlands, riparian habitats, other sensitive botanical communities, and special-status plant species, and the effects of future growth would be analyzed and mitigated during land use planning and environmental review for specific projects. Therefore, this impact would be less than significant. Mitigation is not required for the No-Action Alternative.

CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

CP1 focuses on increasing water supply reliability and increasing anadromous fish survival. This plan primarily consists of raising Shasta Dam by 6.5 feet, which, in combination with spillway modifications, would increase the height of the reservoir's full pool by 8.5 feet and enlarge the total storage capacity in the reservoir by 256,000 acre-feet. The existing TCD would also be extended to achieve efficient use of the expanded cold-water pool. Shasta Dam operational guidelines would continue essentially unchanged, except during dry years[2] and critical years, when 70,000 acre-feet and 35,000 acre-feet, respectively, of the increased storage capacity in Shasta Reservoir would be reserved to specifically focus on increasing M&I deliveries. CP1 would help reduce future water shortages through increasing drought year and average year water supply reliability for agricultural and M&I deliveries. In addition, the increased depth and volume of the cold-water pool in Shasta Reservoir would contribute to

[2] Throughout this document, water year types are defined according to the Sacramento Valley Index Water Year Hydrologic Classification unless specified otherwise.

improving seasonal water temperatures for anadromous fish in the upper Sacramento River.

Shasta Lake and Vicinity

Impact Bot-1 (CP1): Loss of Federally or State-Listed Plant Species Habitat for Federally or State-listed plant species does not occur at Shasta Lake or in the vicinity. No such species are known or expected to occur. Therefore, no impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact Bot-2 (CP1): Loss of MSCS Covered Species Implementation of the project would result in the loss of MSCS-covered species as a result of inundation, vegetation removal, or construction activities. Therefore, this impact would be significant. The only MSCS species known to occur in the project area is Shasta snow-wreath.

Reclamation conducted detailed surveys of all Shasta snow-wreath populations in the vicinity of the project area between March and May 2014 to determine the overall extent of these populations. Surveys were conducted using a total station and survey-grade GPS instruments to obtain accurate population boundaries at each Shasta snow-wreath population. Using the survey information, Reclamation verified whether flooding impacts would occur at each population, and if so, estimates of the amount of loss to each population were calculated using existing topographic information for each dam raise alternative.

Inundation caused by a 6.5-foot dam raise would affect all or portions of nine Shasta snow-wreath populations. These nine populations represent 38 percent of all known Shasta snow-wreath populations and encompass approximately 79 acres. Flooding impacts under CP1 would result in the loss of approximately 1.5 acres, or approximately 2 percent of these nine Shasta snow-wreath populations. The greatest proportional impacts to these populations occur at the Blue Ridge West, Brock Creek, Cove Creek, Keluche Creek, and Shasta Caverns populations. Table 12-14 provides a detailed summary of impacts to Shasta snow-wreath under CP1. Mitigation measures for impacts to Shasta snow-wreath populations are presented in Section 12.3.5, “Mitigation Measures.”

Because complete surveys have not been conducted in the entire impoundment area, other MSCS plant species may be present. In these areas, all or portions of MSCS plant populations could be inundated. This loss of MSCS-covered species and their habitat would be substantial; the impact would be significant. Potential mitigation lands containing comparable habitat and conceptual habitat enhancement projects have been identified adjacent to the project and in the vicinity. Additional discussion of how these lands may be applied as mitigation and at what ratios is provided in Section 12.3.5, “Mitigation Measures.”

Table 12-14. Summary of Impacts to Shasta Snow-wreath Populations Adjacent to Shasta Lake Under CP1

Population	Location	Size (Acres)	CP1 Impact (Acres)	Percent Total Impact to Population	Comments
Blue Ridge (west)	Main Body	1.11	0.470	42%	Lower portion of population would be flooded.
Blue Ridge (east)	Main Body	0.03	0	0%	No impact under CP1.
Brock Creek	Pit River Arm	1.38	0.487	35%	Lower portion of population would be flooded.
Campbell Creek	McCloud River Arm	1.90	0.002	<1%	Small area at the downstream portion of the population would be flooded.
Cove Creek	Main Body	1.87	0.264	14%	Lower portion of population would be flooded.
Ellery Creek	McCloud River Arm	28.65	0.031	<1%	The entire very small disjunct sub-population located near Ellery Creek Campground would be flooded.
Jones Valley	Main Body	0.33	0	0%	No Impact under CP1.
Keluche Creek	McCloud River Arm	0.15	0.085	56%	More than half of the population would be flooded.
Shasta Caverns	McCloud River Arm	0.08	0.018	21%	Lower portion of population would be flooded.
South of Cove Creek	Main Body	1.39	0.143	10%	Lower portion of population would be flooded.
Stein Creek	Pit River Arm	42.15	0.023	<1%	Lower portion of population would be flooded.

Key:
% = percent
< = less than
CP = Comprehensive Plan

Impact Bot-3 (CP1): Loss of USFS Sensitive, BLM Sensitive, or CRPR Species
Implementation of the project would result in the loss of USFS sensitive, BLM sensitive, or CRPR species as a result of inundation, vegetation removal, or construction activities. Therefore, this impact would be potentially significant.

For areas where botanical surveys have been conducted, direct impacts have been determined using GIS to ascertain the populations within the impoundment area, relocation areas, and construction footprints.

Based on results of surveys to date, special-status plant species known to occur in the primary study area include Shasta County arnica, northern clarkia, Cantelow's lewisia, Shasta snow-wreath, slender false lupine, Shasta huckleberry, and Shasta limestone monkeyflower.

Direct impacts to Shasta snow-wreath under CP1 are addressed in Impact Bot-2 (CP1). As a USFS sensitive species, the Shasta snow-wreath is recognized by the USFS to require special management to prevent the species from becoming threatened or endangered. Because the snow-wreath is a Shasta County endemic species, the impacts will result in a decline in populations and habitat and may result in a trend towards listing.

Inundation caused by a 6.5-foot dam raise and activities in the relocation areas could impact all or portions of Shasta County arnica, northern clarkia, Cantelow's lewisia, slender false lupine, Shasta huckleberry, and Shasta limestone monkeyflower populations occurring in the impoundment and relocation areas. Potential populations occurring in the unsurveyed portions of the impoundment area could be flooded and result in a potentially significant impact. Impacts on known populations are provided below.

Inundation of the impoundment area would impact all or portions of the Shasta arnica population south of Bridge Bay Resort on the Main Body of the lake.

Vegetation removal and/or construction activities in the relocation areas would impact all or portions of the northern clarkia populations in Bailey Cove (McCloud Arm).

Inundation of the impoundment area would impact all or portions of the Cantelow's lewisia population on a rock outcrop on the right bank of the Upper Sacramento River riverine reach near the Shasta Lake/upper Sacramento River transition zone. Inundation will also impact populations found along the Sacramento Arm near Elmore Mountain.

Inundation of the impoundment area and vegetation removal in the relocation areas would impact all or portions of 82 slender false lupine populations at scattered locations throughout these areas.

Inundation caused by a 6.5-foot dam raise would impact small portions (approximately 14 shrubs) of four Shasta huckleberry populations located on the Main Body ((little) Squaw Creek, Shoemaker Gulch, Little Backbone Creek) and the Squaw Creek Arm (Horse Creek). These populations extend beyond the project boundary at each location and consist of hundreds to over a thousand shrubs. No Shasta huckleberry population will be completely lost as a result of CP1.Because complete surveys have not been conducted in the entire impoundment area, other USFS sensitive, BLM sensitive, and CRPR species plant species may be present. In these areas, all or portions of USFS sensitive, BLM sensitive, and CRPR species plant populations could be inundated. This would be a potentially significant impact.

Collectively, the loss of USFS sensitive, BLM sensitive, and CRPR species and their habitat would therefore be potentially significant. Mitigation for this impact is described in Section 12.3.5, "Mitigation Measures."

Impact Bot-4 (CP1): Loss of Jurisdictional Waters Implementation of the project will result in the loss of jurisdictional waters caused by flooding the impoundment area and discharge of fill associated with the relocation of facilities and dam construction. Flooding caused by implementation of the project would result in the conversion of jurisdictional water types (e.g., wetlands and streams to lacustrine habitat). Therefore, this impact would be significant.

Direct impacts would occur by conversion of jurisdictional waters (e.g., wetlands and streams) to lacustrine habitat with implementation of CP1. All features within the impoundment area would be converted to lacustrine habitat. Under CP1, approximately 14 acres of wetlands and 19 acres of other waters would be converted to lacustrine habitat (Table 12-15). This will result in a net loss of approximately 14 acres of wetlands. No net loss of other waters will occur under CP1, as lacustrine waters will replace riverine waters; however, lacustrine and riverine waters provide many different functions and values and are separate aquatic resources. The loss of wetlands and the conversion of approximately 19 acres of riverine waters to lacustrine waters would be a significant impact.

Direct impacts on wetlands and other waters that will be filled as a result of relocation of facilities or dam construction are summarized in Table 12-16.

The impact would be significant. Mitigation for this impact is proposed in Section 12.3.5, “Mitigation Measures.”

Table 12-15. Impacts to Jurisdictional Waters (Acres[1]) in the Impoundment Area (6.5-Foot Dam Raise)

Jurisdictional Water Type	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Wetlands							
Fresh emergent/ riparian wetland	0.00	0.00	5.18	0.00	0.00	0.00	5.18
Intermittent swale	0.00	0.00	0.00	0.00	0.00	0.02	0.02
Riparian wetland	0.41	0.49	3.82	1.87	0.35	0.42	7.36
Seasonal wetland	0.00	0.00	0.25	0.00	0.00	0.02	0.27
Seep/spring wetland	0.43	0.14	0.45	0.24	0.05	0.25	1.56
Vegetated ditch	0.00	0.00	0.00	0.003	0.00	0.00	0.003
Total Wetlands	0.84	0.63	9.70	2.11	0.40	0.71	14.39
Other Waters of the United States							
Ephemeral stream	0.13	0.01	0.29	0.13	0.06	0.05	0.67
Intermittent stream	0.67	0.12	1.12	0.41	0.39	1.21	3.92
Perennial stream	0.82	1.00	5.12	5.77	1.10	0.76	14.57
Roadside ditch	0.00	0.00	0.003	0.00	0.00	0.00	0.003
Seep/spring other waters	0.01	0.00	0.001	0.01	0.00	0.00	0.021
Lacustrine	0.00	0.00	0.01	0.00	0.00	0.00	0.01
Total Other Waters	1.63	1.13	6.54	6.32	1.55	2.02	19.19
Total Waters of the U.S.	2.47	1.74	16.24	8.43	1.95	2.73	33.57

Note:
[1] Acreage values are approximate.

Table 12-16. Impacts to Jurisdictional Waters (Acres[1]) in the Relocation Areas (6.5-Foot Dam Raise)

Jurisdictional Water Type	Relocation Acres						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Wetlands							
Fresh emergent wetland	0.00	N/A	0.02	0.01	0.00	0.00	0.03
Intermittent swale	0.00	N/A	0.00	0.00	0.00	0.001	0.001
Riparian wetland	0.03	N/A	0.20	0.02	0.003	0.13	0.38
Seasonal wetland	0.01	N/A	1.75	0.00	0.0001	0.00	1.76
Seep/spring wetland	0.004	N/A	0.03	0.00	0.006	0.005	0.05
Vegetated ditch	0.05	N/A	0.00	0.004	0.00	0.00	0.05
Total Wetlands	0.094	N/A	2.00	0.03	0.009	0.136	2.27
Other Waters of the United States							
Ephemeral stream	0.06	N/A	0.08	0.12	0.001	0.02	0.281
Intermittent stream	0.26	N/A	0.78	0.09	0.007	0.08	1.22
Perennial stream	0.00	N/A	0.05	0.03	0.04	0.002	0.12
Roadside ditch	0.007	N/A	0.003	0.00	0.00	0.00	0.01
Non-vegetated ditch	0.01	N/A	0.003	0.00	0.00	0.00	0.01
Seep/spring other waters	0.00	N/A	0.00	0.00	0.004	0.00	0.004
Total Other Waters	0.337327	N/A	0.92	0.24	0.05	0.102	1.64
Total Waters of the U.S.	0.43	N/A	2.92	0.27	0.06	0.24	3.92

Note:
[1] Acreage values are approximate.
Key:
N/A = not applicable

Impact Bot-5 (CP1): Loss of General Vegetation Habitats Implementation of the project would result in a loss of general vegetation habitats because of inundation, vegetation removal, or construction activities. Therefore, this impact would be potentially significant.

Under CP1, 1,227 acres of general vegetation habitat will be directly impacted by the inundation of the impoundment area and 698 acres of general vegetation habitat will be impacted by vegetation removal in the construction footprints of the relocation areas (Table 12-17 and Table 12-18).

This impact would be potentially significant. Mitigation for this impact is proposed in Section 12.3.5, “Mitigation Measures.”

Table 12-17. Impacts to CWHR Habitats in the Impoundment Area (6.5-Foot Dam Raise)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Annual grassland	0.07	0.00	0.96	0.37	0.00	0.00	1.40
Barren	1.02	0.00	4.04	0.85	0.00	1.64	7.55
Blue oak–foothill pine	4.96	0.00	0.00	0.00	1.40	4.04	10.40
Blue oak woodland	0.00	0.00	0.00	0.00	0.00	1.32	1.32
Closed-cone pine–cypress	17.75	0.00	6.30	10.78	23.95	188.29	247.07
Douglas-fir	0.00	0.00	0.00	0.01	0.00	0.00	0.01
Mixed chaparral	14.83	6.83	80.01	7.32	5.43	27.73	142.15
Montane hardwood	39.08	18.13	86.75	34.61	9.44	1.28	189.29
Montane hardwood–conifer	34.65	0.50	69.23	66.31	55.70	5.68	232.07
Montane riparian	1.54	2.48	15.92	4.60	0.58	0.80	25.92
Ponderosa pine	108.93	15.36	84.75	81.20	25.06	29.93	345.23
Riverine	0.00	0.35	2.30	3.81	0.59	0.00	7.05
Urban	10.95	0.00	1.37	4.74	0.00	0.75	17.81
Total	233.79	43.65	351.64	214.60	122.14	261.46	1227.27

Note:
[1] Acreage values are approximate.
Key:
CWHR = California Wildlife Habitat Relationship

Table 12-18. Impacts to CWHR Habitats in the Relocation Areas

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Annual grassland	0.40	0.00	4.95	0.53	0.70	0.01	6.59
Barren	12.46	0.00	11.97	5.38	0.00	2.96	32.76
Blue oak–foothill pine	0.01	0.00	0.00	0.00	0.00	2.35	2.36
Closed-cone pine–cypress	0.05	0.00	5.65	2.23	0.23	0.94	9.11
Mixed chaparral	3.36	0.00	3.95	4.11	1.70	9.63	22.77
Montane hardwood	19.73	0.00	20.89	21.64	0.24	0.13	66.63
Montane hardwood–conifer	24.69	0.00	19.27	33.48	2.61	6.62	86.66
Montane riparian	0.08	0.00	0.33	0.25	0.04	0.02	0.72
Ponderosa pine	79.56	0.00	96.78	47.58	16.04	0.77	240.74
Urban	15.64	0.00	217.29	0.27	0.00	0.57	233.76
Total	155.98	0.00	381.09	115.47	21.56	23.99	698.10

Note:
[1] Acreage values are approximate.
Key:
CWHR = California Wildlife Habitat Relationship

Impact Bot-6 (CP1): Spread of Noxious and Invasive Weeds Implementation of the project could result in the spread of noxious and invasive weeds as a result of ground-disturbing activities during construction and an increased number of vectors (means of dispersal). Therefore, this impact would be potentially significant.

Noxious and invasive weeds are abundant around Shasta Lake, specifically in the relocation areas. Vectors that would increase as a result of project implementation include weed seed and seed parts brought in on tools, vehicles, and workers' clothing and boots. The extent of the risk would depend on the construction methods used and site-specific actions implemented to complete the project. As access into specific project areas is improved, road construction, temporary roads, and road maintenance would increase the number of vectors in an area. As traffic along new and existing corridors increases, the risk for weed dispersal would increase. Seed mixtures and mulches may be used during erosion control efforts and revegetation of areas. These mixtures and mulches are potential vectors for noxious weed and invasive plant dispersal.

Construction of the dam would result in inundation of shoreline habitat. Depending on the extent of colonization, many populations of noxious weeds could be inundated. However, there would be no increase in vector traffic and no soil disturbance due to inundation. Therefore, the risk of weed spread from the inundation of habitat is low.

However, vegetation removal in areas to be inundated may increase risk of weed spread. Habitat vulnerability and project-associated vectors in inundation zones would be variable, based on the extent of the vegetation removal and the location of the proposed activity. All habitats are vulnerable when canopies are opened and soil is disturbed. Increased traffic and soil disturbance coupled with an adjacent, high-ranking noxious weed may result in a moderate to high risk of weed spread.

Because of the dam expansion, other ground-disturbing projects would be implemented to relocate displaced roads, railways, utilities, homes, and recreation facilities. The potential for disturbance of noxious weeds is highly variable, based on the proposed activity and the abundance of weeds present. Depending on the location of high-ranking noxious weeds, the extent of ground-disturbing activities, and the amount of traffic entering a project site, the risk of noxious weed infestation would vary.

This impact would be potentially significant. Mitigation for this impact is proposed in Section 12.3.5, "Mitigation Measures."

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact Bot-7 (CP1): Altered Structure and Species Composition and Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Altered Flow Regimes Altered flow regimes associated with project implementation under CP1 could alter the structure and species composition or cause the loss of riparian, wetland, and oak communities, and habitat for special-status plant species. Vernal pool plant communities and associated special-status species likely would not be affected. Effects on oak communities and upland habitats for special-status plants may not all be adverse. Adverse effects on riparian and wetland communities and associated special-status plants could be substantial; thus, this impact would be significant.

Potential impacts on structure and species composition and loss of sensitive plant communities and special-status plant species resulting from altered flow regimes were determined using the best available information and tools as described in Chapter 2 “CalSim-II” and Chapter 3 “Temporal Downsizing of CalSim-II Flows for Use in Temperature Modeling” of the Engineering Appendix. See Chapter 4 “Geology, Geomorphology, Minerals, and Soils,” for additional information on fluvial geomorphology and hydrology, and channel erosion and meander migration.

Potential impacts on flow and stages of the upper Sacramento River from CP1 would be small. On average, in each month, changes in mean monthly flow would be reductions or increases of several percent. Generally, these effects diminish with distance downstream because of the influence of inflows from tributaries and of diversions and flood bypasses.

In average and wet years, river flows would decrease during the November through February period of some years. This would be because of the increased storage space that could be filled in some years, usually following dry or critical water years.

During March through May, changes in mean monthly flows would be small reductions or increases (generally less than 2 percent) typically transitional between small reductions in winter flows and small increases in summer flows. During the June through August period of some years, flow and stage would increase. This increase would be most pronounced during some dry years as more water is released from Shasta Dam for water supply reliability purposes. During March, September, and October, mean monthly flows would generally be increased 1 to 6 percent.

Northern hardpan vernal pools and northern volcanic mudflow vernal pools are not present at Shasta Dam and are generally not present within the active floodplain immediately adjacent to the channel of the upper Sacramento River or its tributaries in the primary study area. Therefore, northern hardpan vernal pools and associated special-status plant species would likely not be affected by the altered flows in the primary study area downstream from Shasta Dam.

The altered flow regime of the upper Sacramento River associated with implementation of CP1 could affect oak communities and upland habitat for special-status plant species by prolonging inundation and changing the availability of soil moisture. Prolonged inundation during the growing season kills most upland plants. This effect would occur during years when mean monthly stage during March – October is greater than in preceding years. Interannual fluctuations in stage during the growing season already cause upland vegetation to become removed from (or prevent its establishment within) a zone along rivers downstream from Shasta Dam. CP1 could increase the average elevation of this zone slightly (by, on average, increasing stage during the growing season of most years), but it would not increase the zone's elevation range. For some upland vegetation, greater summer flows in some years also could increase summer soil moisture, and reduced intermediate and large flows during winter in some years could reduce spring soil moisture. Because of the important influence of water availability on plant growth and survival, these changes in the availability of moisture could change the structure and species composition of oak communities or affect special-status plants of upland habitats.

These effects, however, are speculative, and may not all prove to be adverse with project implementation and operation. For example, greater summer flows in some years could increase summer soil moisture; in dry years, increased soil moisture could sustain plants that otherwise would be damaged or die. Therefore, the impact on oak communities and on upland habitat for special-status plants resulting from altered flow regimes on the upper Sacramento River within the primary study area would be less than significant.

The flow regime of a river or stream strongly influences the structure and species composition of the riparian and wetland communities associated with it. For this reason, the altered flow regimes resulting from project implementation would affect riparian and wetland vegetation. These effects are described below.

River flows strongly affect the growth and survival of riparian plants. Riparian plants are strongly affected by the timing and duration of inundation; abrasion and burial by water-borne sediment; and by water table fluctuations (Toner and Keddy 1997; Friedman and Auble 1999; Karrenberg, Edwards, and Kollmann 2002; Bagstad, Stromberg, and Lite 2005; Lite and Stromberg 2005; Williams and Cooper 2005). As a result, riparian communities often differ in structure and species composition along gradients of elevation or flooding frequency and intensity (Conard, MacDonald, and Holland 1977; Harris 1987; Toner and Keddy 1997; Bagstad, Stromberg, and Lite 2005; Vaghti and Greco 2007).

River flows not only affect the survival and growth of established riparian vegetation, but also create sites for establishment of early-successional vegetation. The geomorphic processes of channel meander migration, avulsion, and deposition of sediment on floodplains, which result primarily from intermediate and large flows, bury and uproot herbaceous vegetation and uproot or undercut trees and shrubs. These disturbances also create opportunities for early-successional vegetation to establish, including willow and cottonwood seedlings that grow to form willow scrub and Great Valley cottonwood riparian forest.

Early successional riparian communities change rapidly in structure and species composition (Tu 2000, Fremier 2003, Vaghti and Greco 2007). Over several decades, early-successional vegetation develops into mid- and late-successional vegetation with less willow and cottonwood and a greater abundance of other trees, including box-elder, Oregon ash, black walnut, and valley oak (e.g., Great Valley mixed riparian forest) (Fremier 2003).

Thus, for riparian vegetation, the rates of geomorphic processes strongly affect the extent of different riparian communities, and these rates are strongly related to flow regime. For example, bank erosion and the average rate of meander migration are closely related to the cumulative portion of flow above a threshold volume. On portions of the Sacramento River, this threshold may be around 30,000 cfs (Larsen, Fremier, and Greco 2006; Stillwater Sciences 2007), which is well below the bankfull discharge but well above flows during spring and summer. However, other important thresholds for bank erosion and channel avulsion along the Sacramento River have been estimated within the range from 10,000 to 80,000 cfs (Stillwater Sciences 2007). (For additional discussion of the relationship of geomorphic processes to flow along the Sacramento River, see the *Fisheries and Aquatic Ecosystem Technical Report*.)

Flow regimes during the period of seed dispersal also strongly influence establishment of seedlings of riparian trees and shrubs, particularly willows and cottonwoods. In general, seeds of riparian plants can only successfully germinate and establish on exposed surfaces; prolonged inundation of a surface during the growing season prevents establishment. Willows and cottonwoods have very small, short-lived seed and are shade-intolerant plants; thus, their seeds must disperse to exposed, moist surfaces that are largely free of vegetation. Such surfaces are often created by channel migration, avulsion, and sediment deposition during larger winter and spring flows. They are then exposed by declining flows during the seed dispersal period of willow and cottonwood species. These seed dispersal periods are staggered across spring and summer; for example, March through April for arroyo willow, April through June for cottonwood, and May through August for black willow. Once willow and cottonwood seeds germinate, slowly declining flows are necessary to maintain their roots in contact with saturated soils, which in turn is necessary for establishment. Rapidly declining flows (i.e., those greater than 1 to 1.5 inches per day) result in desiccation and mortality of seedlings (Mahoney and Rood 1998, Stillwater Sciences 2007). Conversely, flows that increase during the growing season kill many seedlings (e.g., by burial, uprooting, or scouring).

Consequently, reductions in the magnitude, duration, and frequency of intermediate and large flows could reduce opportunities for cottonwood and willow species to establish and thus limit the extent of early and mid-successional riparian communities. The absence of slowly declining spring flows also would reduce cottonwood establishment.

Since its construction, the operation of Shasta Dam has limited the frequency, magnitude, and duration of intermediate and larger flows during fall and winter, and flow volumes have been greater during the growing season. The operation of Shasta Dam also produces increasing flow volumes during the period of cottonwood seed dispersal (rather than flow volume decreasing during this period), largely precluding establishment of cottonwoods (and to a lesser extent willows) throughout much of the riparian zone (Roberts et al. 2002). The combined effect of these changes in flow regime has been a decrease in early- and mid-successional communities along the Sacramento River that is ongoing (Fremier 2003).

CP1 would lead to a further reduction in the magnitude, duration, and frequency of intermediate and large flows, but it would not alter the general annual pattern of flows increasing during the cottonwood seed dispersal period. However, CP1's effects on larger flows could further reduce the frequency or extent of suitable conditions for cottonwoods to establish from seed. Overall, the project would increase the existing, ongoing impacts on riparian vegetation resulting from the operation of Shasta Dam. This could reduce the area of riparian vegetation slightly, and reduce the proportion of riparian vegetation that is in early- and mid-successional stages (e.g., willow- and cottonwood-dominated communities) while increasing the extent of mid-successional communities (e.g., mixed riparian forest). This would be an exacerbation of an ongoing transition (which is described under Impact Bot-7 (No-Action)). These effects would not substantially alter the establishment and spread of invasive plant species. There would, however, be some reduction in the magnitude, duration, and frequency of overbank flows that facilitate the dispersal and establishment of invasive plants, and some reduction in the amount of early successional vegetation that provides suitable habitat for many invasive plant species.

These effects would likely occur along the upper Sacramento River throughout the primary study area. Reductions in the magnitude of intermediate and large flows would likely be sufficient to alter the dynamics and structure of the riparian corridor along the upper Sacramento River, downstream from Shasta Dam, throughout the primary study area. These effects on flows greater than 30,000 cfs downstream from Keswick Dam, RBPP, and Hamilton City are shown on Figure 12-6. As described previously, flows of this magnitude strongly affect bank erosion and meander migration, and are related to other geomorphic processes affecting the extent of different riparian communities. In the primary study area, there would be a small reduction in the number of mean daily flows greater than 30,000 cfs. Downstream from Keswick and the RBPP the number of days with mean flows greater than 30,000 cfs would be reduced by approximately 9 and 2 percent, respectively.

Although the establishment of most wetland plants is less strongly influenced by specific attributes of the flow regime than willows and cottonwoods, flow regime still plays an important role in wetland communities. In general, wetland communities on floodplains are strongly influenced by timing and duration of inundation, scour and deposition of sediment, and fluctuations in water table elevations within and among years (Keddy 2000, Leyer 2005, van Eck et al. 2006). Changes in flow during some years would change the extent of some wetland communities (e.g., seeps, seasonal wetlands) during that year and/or subsequent years, and thus the average extent of those communities. Overall, wetland communities could experience effects similar to those described for riparian communities.

For the reasons outlined above, and because riparian and wetland communities are sensitive natural communities, this impact would be significant.

Ten special-status plant species could occur in riparian or wetland habitats in the primary study area (including mesic upland-associated species; Table 12-6). Of these, within the primary study area and nearby counties (Butte and Glenn), three are known to occur along the edge of the Sacramento River channel, or along a Sacramento River tributary within 0.2 mile of the river proper, and their establishment and reproduction could potentially be affected by changes in flow regime: silky cryptantha (CRPR 1B), rose mallow (CRPR 2B.2), and Ahart's paronychia (CRPR 1B) (CNDDB 2007, University of California 2011). Because altered flow regimes associated with the project could modify habitat for these special-status species, this impact would be significant.

Mitigation for this impact is proposed in Section 12.3.5, "Mitigation Measures."

Impact Bot-8 (CP1): Conflict with Approved Local or Regional Plans with Objectives of Riparian Habitat Protection or Watershed Management
Numerous local and regional plans promote the conservation of riparian vegetation and associated habitats along the upper Sacramento River. Because CP1 would adversely affect riparian communities, this alternative could conflict with existing local and regional plans focused on preserving riparian habitats. Therefore, this impact would be potentially significant.

Local and regional plans addressing riparian habitats in the primary study area are discussed in more detail in the "Regulatory Setting" section of this EIS and include the RHJV and the Sacramento River Conservation Area Program, both of which promote the conservation and the restoration of riparian habitat. As described for Impact Bot-7 (CP1), implementation of this alternative could cause substantial adverse effects on riparian and wetland communities by altering the flow regime of the upper Sacramento River and could, therefore, conflict with existing local and regional plans that aim to conserve riparian habitats. Therefore, this impact would be potentially significant. Mitigation for this impact is proposed in Section 12.3.5, "Mitigation Measures."

Impact Bot-9 (CP1): Disturbance or Removal of Designated Critical Habitat for Special-Status Species Designated critical habitat for four vernal pool special-status plant species exists within the primary study area. However, such critical habitat is not expected to be adversely affected by CP1. This impact would be less than significant.

Critical habitat for four special-status species — slender orcutt grass, Hoover's spurge, hairy orcutt grass, and Greene's tuctoria — exists within the primary study area. Critical habitat for these species in the primary study area is confined to vernal pool communities (USFWS 2006). Vernal pools are generally not present within the active floodplain. However, if vernal pool habitats for these special-status species are present in the active floodplain of the upper Sacramento River, they could be affected by the small reduction in the frequency and magnitude of overbank flows. It is not known if this would be an adverse or beneficial effect. Because this effect of CP1 is somewhat speculative and not necessarily adverse, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Bot-10 (CP1): Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Induced Growth Implementing CP1 could increase water supplies for deliveries to water districts in the primary study area along the upper Sacramento River. This increase in water deliveries could reduce any limitation on urban growth and development that could affect sensitive plant communities and special-status plant species. However, this increase in water supplies for growth that could affect these resources would be small, and in the future the effects of this growth would be analyzed and mitigated during land use planning and environmental review for specific projects. For these reasons, this impact would be less than significant.

Along the upper Sacramento River, the CVP and SWP service areas contain wetland, riparian, oak, and other sensitive plant communities, and a large number of special-status plant species (Attachment 4). Increased water supplies or increased supply reliability could reduce a limitation on urban growth and development or on other activities that could affect sensitive plant communities or special-status plants in the primary and extended study areas.

The expected increase in water deliveries relative to the entire CVP and SWP service areas would be small (i.e., less than 1 percent), however, and increased deliveries would be provided to a number of geographic areas within the CVP and SWP service areas. Also, a substantial portion of this water would substitute for groundwater pumping, allow for changes in crop type or agricultural irrigation practices, or return idle cropland to production. Consequently, this alternative's effect on growth that could affect vegetation would be minor.

Furthermore, the effects of this growth would be analyzed in general plan EIRs and in project-level CEQA compliance documents for the local jurisdictions in which the growth would occur. Mitigation of these effects would be the responsibility of these local jurisdictions, and not of Reclamation. Similarly, projects potentially affecting riparian and wetland habitats and listed species would require permits from CDFW, USACE, and USFWS; it is anticipated that effects on these resources would be avoided, minimized, and/or mitigated during those agency consultations.

The extent of induced growth that could affect botanical resources and wetlands would likely be minor, and in the future the effects of this growth would be analyzed and mitigated during land use planning and environmental review for specific projects. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Bot-11 (CP1): Loss of Sensitive Natural Communities or Habitats Resulting from Implementing the Gravel Augmentation Program or Restoring Riparian, Floodplain, and Side Channel Habitats The proposed gravel augmentation program and riparian, floodplain, and side channel restoration activities would not be implemented under CP1. Therefore, no impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact Bot-12 (CP1): Loss of Special-Status Plants Resulting from Implementing the Gravel Augmentation Program or Restoring Riparian, Floodplain, and Side Channel Habitats The proposed gravel augmentation program and riparian, floodplain, and side channel restoration activities would not be implemented under CP1. Therefore, no impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact Bot-13 (CP1): Spread of Noxious and Invasive Weeds Resulting from Implementing the Gravel Augmentation Program or Restoring Riparian, Floodplain, and Side Channel Habitats The proposed gravel augmentation program and riparian, floodplain, and side channel restoration activities would not be implemented under CP1. Therefore, no impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta

Impact Bot-14 (CP1): Altered Structure and Species Composition and Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Altered Flow Regimes on the Lower Sacramento River Altered flow regimes associated with project implementation under CP1 could alter the structure and species composition or cause the loss of riparian, wetland, and oak communities, and loss of habitat for special-status plant species. Vernal pool plant communities and associated special-status plant species likely would not be affected. Effects on oak communities and upland habitats for special-status plants may not all be adverse. Adverse effects on riparian and wetland communities and associated special-status plants could be substantial on the lower Sacramento River, but these effects are unlikely to extend to the Delta; thus, this impact would be significant on the lower Sacramento River, and less than significant in the Delta.

This impact would be similar to Impact Bot-7 (CP1) for the upper Sacramento River, but alteration of the Sacramento River's flow regime would be attenuated in the lower river by the effects of inflows from tributaries and of diversions and flood bypasses. Measurable effects on riparian and wetland plant communities are unlikely to extend as far downstream as the Delta, in part because releases from Shasta Dam account for a smaller fraction of total flow with increasing distance downstream as tributaries cumulatively add to the Sacramento River's flow.

Nonetheless, significant impacts on riparian and wetland communities, and associated special-status plants, would be caused on the lower Sacramento River, particularly near the upper Sacramento River. South of RBPP, the portion of the Sacramento River's total annual flow that is accounted for by flows greater than 30,000 cfs would still be reduced, and also the frequency of flows greater than 60,000 to 80,000 cfs (i.e., roughly the size of the current 1.5- to 2-year events) would be reduced. Changes in the number of days with mean daily flows greater than 30,000 cfs downstream from RBPP and Hamilton City are summarized on Figure 12-6. (These two locations are shown on Figure 12-7.) As described for Impact Bot-7 (CP1) (and in the *Fisheries and Aquatic Ecosystem Technical Report*), flows above about 30,000 cfs and 1.5- to 2-year events cause substantial changes in riparian ecosystems. These changes indicate that although they would be small, the alterations to the lower Sacramento River's flow regime could be sufficient to cause significant impacts in the Red Bluff-to-Chico Landing reach. This reach is immediately downstream from the primary study area but upstream from the flood bypasses and the Feather and American rivers, which substantially attenuate the effects of flows released from Shasta Dam. This reach is mostly unleveed and has few other constraints to channel movement, river meander, and flooding; consequently, it has an extensive acreage of early-, mid-, and late-successional riparian communities (Resources Agency 2003).

Effects are unlikely to extend to the Delta because the flood bypasses and the Feather and American rivers attenuate the effects of flows released from Shasta Dam. In addition, much of the Sacramento River's length south of Colusa, and almost all Delta sloughs, are leveed (often close to the channel) with extensive reinforcement of channel banks with revetment, restricting channel movement, river meander and flooding. Further; the acreage of early-, mid-, and late-successional riparian communities is much less extensive along the Sacramento River south of Colusa and in the Delta.

Effects of flow alterations are also unlikely to extend to the Delta because the Central Valley's reservoirs and diversions are managed as a single integrated system (consisting of the CVP and SWP). The guidelines for this management, which are described in the CVP Operations Criteria and Plan, have been designed to maintain standards for Delta inflow. CVP and SWP operations must be consistent with the Operations Criteria and Plan to allow coverage by the Operations Criteria and Plan biological opinion. Thus, implementation of CP1 is not anticipated to alter Sacramento River flows to the Delta sufficiently to alter the dynamics or structure of vegetation in the Delta. Thus, impacts on the Delta portion of the extended study area would be less than significant.

This impact would be significant along the lower Sacramento River and less than significant in the Delta. Mitigation for this impact along the lower Sacramento River is proposed in Section 12.3.5, “Mitigation Measures.”

Impact Bot-15 (CP1): Conflict with Approved Local or Regional Plans with Objectives of Riparian Habitat Protection or Watershed Management Along the Lower Sacramento River Adopted local and regional plans address and promote the conservation of riparian vegetation and associated habitats along the lower Sacramento River. Because CP1 would adversely affect riparian communities, this alternative could conflict with existing local and regional plans focused on preserving riparian habitats. Therefore, this impact would be potentially significant.

Numerous local and regional plans address and promote the conservation of riparian vegetation and associated habitats along the lower Sacramento River and in the Delta. These plans, which are discussed in more detail in the “Regulatory Framework” of this EIS, include the RHJV and the Sacramento River Conservation Area Program, both of which promote the conservation and restoration of riparian habitat. As described for Impact Bot-14 (CP1), implementation of this alternative could cause substantial adverse effects on riparian and wetland communities along a portion of the lower Sacramento River by altering its flow regime, but such effects would not occur in the Delta. Because the project has the potential to result in substantial adverse effects on riparian communities, it could conflict with existing local and regional plans. Therefore, on the lower Sacramento River, this impact would be potentially significant. Mitigation for this impact is proposed in Section 12.3.5, “Mitigation Measures.”

Impact Bot-16 (CP1): Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Induced Growth Along the Lower Sacramento River and in the Delta Implementation of CP1 could increase water supplies for deliveries to water districts in the extended study area along the lower Sacramento River. This increase in water deliveries could reduce a limitation on urban growth and development that could affect sensitive plant communities and special-status plant species. However, this increase in water supplies for growth that could affect these resources would be small, and in the future the effects of this growth would be analyzed and mitigated during land use planning and environmental review for specific projects. For these reasons, this impact would be less than significant.

This impact would be similar to Impact Bot-10 (CP1) for the upper Sacramento River, but the increased water supplies available along the lower Sacramento River would differ from that along the upper Sacramento River. However, for the same reasons as Impact Bot-10 (CP1), this impact would also be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CVP/SWP Service Areas

Impact Bot-17 (CP1): Altered Structure and Species Composition and Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Altered Flow Regimes in the CVP/SWP Service Areas Altered flow regimes associated with project implementation under CP1 could alter the structure and species composition or cause the loss of sensitive plant communities and habitat for special-status plant species. However, alteration of flow regimes below CVP and SWP reservoirs in the extended study area would be less than below Shasta Dam along the upper and lower Sacramento River. These alterations may not be sufficient to alter the extent of early successional riparian and wetland communities or of associated habitat for special-status species. Therefore, below CVP and SWP reservoirs in the extended study area, this impact would be less than significant.

Because CVP and SWP reservoirs and diversions are managed as a single integrated system, changing releases from Shasta Dam can result in offsetting releases from other reservoirs (e.g., to meet Delta inflow standards). The effects from CP1 on CVP and SWP reservoir elevations, filling, spilling, and planned releases, and the resulting flows downstream from those reservoirs, would be small and within the range of variability that commonly occurs in these reservoirs and downstream. These alterations may not be sufficient to alter the extent of early successional riparian and wetland communities or of associated habitat for special-status species. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Bot-18 (CP1): Conflict with Approved Local or Regional Plans with Objectives of Riparian Habitat Protection or Watershed Management in the CVP/SWP Service Areas Adopted local and regional plans address and promote the conservation of riparian vegetation and associated habitats along rivers below reservoirs in the CVP and SWP service areas. However, implementing CP1 would not cause a significant impact on riparian vegetation and habitats. Therefore, CP1 would not conflict with existing local and regional plans focused on preserving riparian habitats. Thus, in the CVP and SWP service areas, this impact would be less than significant.

Local and regional plans address and promote the conservation of riparian vegetation and associated habitats in the CVP and SWP service areas. (These plans are discussed in more detail in Section 12.2, “Regulatory Framework.”) However, as described for Impact Bot-17 (CP1), implementation of CP1 would not cause significant impacts on riparian and wetland communities in the CVP and SWP service areas. Therefore, CP1 would not conflict with existing local and regional plans. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Bot-19 (CP1): Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Induced Growth in the CVP/SWP Service Areas Implementation of CP1 could increase water supplies for deliveries to water districts in the CVP and SWP service areas. This increase in water deliveries could reduce a limitation on urban growth and development that could affect sensitive plant communities and special-status plant species. However, this increase in water supplies for growth that could affect these resources would be small, and in the future the effects of this growth would be analyzed and mitigated during land use planning and environmental review for specific projects. For these reasons, this impact would be less than significant.

This impact would be similar to Impact Bot-10 (CP1) for the upper Sacramento River, but the increased water supplies available in the CVP and SWP service areas would differ from that along the upper Sacramento River. However, for the same reasons as Impact Bot-10 (CP1), this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

As with CP1, CP2 focuses on increasing water supply reliability and increasing anadromous fish survival. CP2 primarily consists of raising Shasta Dam by 12.5 feet, which, in combination with spillway modifications, would increase the height of the reservoir’s full pool by 14.5 feet and enlarge the total storage capacity in the reservoir by 443,000 acre-feet. The existing TCD would also be extended to achieve efficient use of the expanded cold-water pool. Shasta Dam operational guidelines would continue essentially unchanged, except during dry years and critical years, when 120,000 acre-feet and 60,000 acre-feet, respectively, of the increased storage capacity in Shasta Reservoir would be reserved to specifically focus on increasing M&I deliveries. CP2 would help reduce future water shortages through increasing drought year and average year water supply reliability for agricultural and M&I deliveries. In addition, the increased depth and volume of the cold-water pool in Shasta Reservoir would contribute to improving seasonal water temperatures for anadromous fish in the upper Sacramento River.

Shasta Lake and Vicinity

Impact Bot-1 (CP2): Loss of Federally or State-Listed Plant Species Habitat for Federally or State-listed plant species does not occur at Shasta Lake or in the vicinity. No species are known or expected to occur. Therefore, no impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact Bot-2 (CP2): Loss of MSCS Covered Species Implementation of the project would result in the loss of MSCS covered species because of inundation, vegetation removal, or construction activities. Therefore, this impact would be significant. Impacts related to dam construction and vegetation clearing within the relocation areas would be similar to but greater than CP1. However, inundation caused by a 12.5-foot raise of Shasta Dam would affect all or portions of ten Shasta snow-wreath populations. These ten populations represent 42 percent of all known Shasta snow-wreath populations and encompass approximately 79 acres. Flooding impacts under CP2 would result in the loss of approximately 1.8 acres, or approximately 2 percent of these ten Shasta snow-wreath populations. The greatest proportional impacts to these populations occur at the Blue Ridge West, Brock Creek, Cove Creek, Keluche Creek, and Shasta Caverns populations. Table 12-19 provides a detailed summary of impacts to Shasta snow-wreath under CP2. Mitigation measures for impacts to Shasta snow-wreath populations are presented in Section 12.3.5, “Mitigation Measures.”

The impact would be significant. Mitigation for this impact is proposed in Section 12.3.5, “Mitigation Measures.”

Table 12-19. Summary of Impacts to Shasta Snow-Wreath Populations Adjacent to Shasta Lake Under CP2

Population	Location	Size (Acres)	CP2 Impact (Acres)	Percent Total Impact to Population	Comments
Blue Ridge (west)	Main Body	1.11	0.594	53%	More than half of the population would be flooded.
Blue Ridge (east)	Main Body	0.03	0	0%	No impact under CP2.
Brock Creek	Pit River Arm	1.38	0.545	39%	Lower portion of population would be flooded.
Campbell Creek	McCloud River Arm	1.90	0.002	<1%	Small area at the downstream portion of the population would be flooded.
Cove Creek	Main Body	1.87	0.337	18%	Lower portion of population would be flooded.
Ellery Creek	McCloud River Arm	28.65	0.038	<1%	The entire very small disjunct sub-population located near Ellery Creek Campground would be flooded.
Jones Valley	Main Body	0.33	0.003	1%	Small area at lower portion or population would be flooded.
Keluche Creek	McCloud River Arm	0.15	0.112	73%	Nearly ¾ of the population would be flooded.
Shasta Caverns	McCloud River Arm	0.08	0.026	31%	Lower portion of population would be flooded.
South of Cove Creek	Main Body	1.39	0.149	11%	Lower portion of population would be flooded.
Stein Creek	Pit River Arm	42.15	0.028	<1%	Lower portion of population would be flooded.

Key:
% = percent
< = less than
CP = Comprehensive Plan

Impact Bot-3 (CP2): Loss of USFS Sensitive, BLM Sensitive, or CRPR Species Implementation of the project would result in the loss of USFS sensitive, BLM sensitive, or CRPR species as a result of inundation, vegetation removal, or construction activities. Therefore, this impact would be potentially significant.

Impacts related to dam construction and vegetation clearing within the relocation areas would be similar to but greater than CP1. However, inundation caused by a 12.5-foot raise of Shasta Dam could result in the loss of more individual plants or plant populations and their habitat.

Impacts to Shasta County arnica, northern clarkia, Cantelow's lewisia, and Shasta limestone monkeyflower populations resulting from CP2 are similar to those described for CP1; however, CP2 would impact 85 slender false lupine populations. Impacts to Shasta huckleberry resulting from CP2 are the same as those described for CP1. This impact would be potentially significant. Mitigation for this impact is proposed in Section 12.3.5, "Mitigation Measures."

Impact Bot-4 (CP2): Loss of Jurisdictional Waters Implementation of the project will result in the loss of jurisdictional waters caused by flooding the impoundment area and discharge of fill associated with the relocation of facilities and dam construction. Flooding caused by implementation of the project would result in the conversion of jurisdictional water types (e.g., wetlands and streams to lacustrine habitat). Therefore, this impact would be significant.

Direct impacts would incur by conversion of jurisdictional waters (e.g., wetlands and streams) to lacustrine habitat with implementation of CP2. All features within the impoundment area would be converted to lacustrine habitat. Under CP2, approximately 19 acres of wetlands and 26 acres of other waters would be converted to lacustrine habitat (Table 12-20). This will result in a net loss of approximately 19 acres of wetlands and loss of approximately 26 acres of riverine waters by conversion to lacustrine waters. The impacts associated with relocation are the same as Impact Bot-4, CP1 as shown on Table 12-16. The impacts to wetlands from relocations would result in the loss of approximately 2.3 acres of wetlands and 1.6 acres of other waters.

Table 12-20. Impacts to Jurisdictional Waters (Acres[1]) in the Impoundment Area (12.5-Foot Dam Raise)

Jurisdictional Water Type	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Wetlands							
Fresh emergent/ riparian wetland	0.00	0.00	5.32	0.00	0.00	0.00	5.32
Intermittent swale	0.00	0.00	0.00	0.00	0.00	0.02	0.02
Riparian wetland	0.75	0.68	5.67	2.84	0.67	0.63	11.24
Seasonal wetland	0.00	0.00	0.29	0.00	0.08	0.02	0.39
Seep/spring wetland	0.58	0.17	0.60	0.21	0.10	0.37	2.03
Vegetated ditch	0.08	0.00	0	0.01	0.00	0.00	0.09
Total Wetlands	1.41	0.85	11.88	3.05	0.85	1.04	19.08
Other Waters of the United States							
Ephemeral stream	0.19	0.01	0.40	0.19	0.09	0.07	0.95
Intermittent stream	1.00	0.15	1.60	0.59	0.61	1.70	5.65
Perennial stream	1.15	1.32	7.46	7.56	1.57	0.94	20.00
Roadside ditch	0.00	0.00	0.004	0.00	0.00	0.00	0.04
Seep/spring other waters	0.02	0.00	0.001	0.01	0.00	0.00	0.03
Total Other Waters	2.36	1.48	9.47	8.35	2.27	2.71	26.64
Total Waters of the U.S.	3.77	2.33	21.35	11.40	3.12	3.75	45.72

Note:
[1] Acreage values are approximate.

The impact would be significant. Mitigation for this impact is proposed in Section 12.3.5, "Mitigation Measures."

Impact Bot-5 (CP2): Loss of General Vegetation Habitats Implementation of the project would result in a loss of general vegetation habitats because of inundation, vegetation removal, or construction activities. Therefore, this impact would be potentially significant.

Under CP2, a total of 1,725 acres of general vegetation habitats will be directly impacted by the inundation of the impoundment area (Table 12-21).

Table 12-21. Impacts to CWHR Habitats (Acres*) in the Impoundment Area (12.5-Foot Dam Raise)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Annual grassland	0.36	0.00	1.53	0.53	0.00	0.00	2.42
Barren	1.40	0.00	5.58	1.86	0.00	2.56	11.40
Blue oak – foothill pine	7.05	0.00	0.00	0.00	2.46	5.27	14.79
Blue oak woodland	0.00	0.00	0.00	0.00	0.00	1.65	1.65
Closed-cone pine – cypress	24.40	0.00	8.95	14.96	32.72	262.31	343.35
Douglas-fir	0.00	0.00	0.00	0.06	0.00	0.00	0.06
Mixed chaparral	20.58	9.56	112.76	11.02	7.35	40.11	201.40
Montane hardwood	53.30	25.75	120.48	48.59	13.31	1.77	263.20
Montane hardwood – conifer	48.77	0.70	99.06	94.36	78.41	7.73	329.03
Montane riparian	2.72	3.23	20.57	6.12	1.00	1.19	34.83
Ponderosa pine	152.04	21.54	123.71	114.71	35.08	40.92	488.00
Riverine	0.00	0.42	4.02	4.51	0.84	0.00	9.80
Urban	16.65	0.00	1.63	6.42	0.00	1.24	25.94
Total	327.28	61.20	498.30	303.14	171.18	364.75	1725.85

Note:
[1] Acreage values are approximate.

The impact would be potentially significant. Mitigation for this impact is proposed in Section 12.3.5, "Mitigation Measures."

Impact Bot-6 (CP2): Spread of Noxious and Invasive Weeds Implementation of the project could result in the spread of noxious and invasive weeds as a result of ground-disturbing activities during construction and an increased number of vectors (means of dispersal). Therefore, this impact would be potentially significant.

Impacts resulting from the spread of noxious weeds under CP2 are anticipated to be similar to, but greater than, those described for CP1. This impact would be potentially significant. Mitigation for this impact is proposed in Section 12.3.5, "Mitigation Measures."

Upper Sacramento River (Shasta Dam to Red Bluff)
Impact Bot-7 (CP2): Altered Structure and Species Composition and Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Altered Flow Regimes Altered flow regimes associated with project implementation under CP2 could alter the structure and species composition or cause the loss of riparian, wetland, and oak communities, and habitat for special-status plant species. Vernal pool plant communities and associated special-status species likely would not be affected. Effects on oak communities and upland habitats for special-status plants may not all be adverse. For example, greater summer flows in some years could increase summer soil moisture, especially during some dry and critical years as more water is released

from Shasta Dam for water supply reliability purposes. (Shasta Dam operations historically have increased flow volumes from mid-spring to early summer.) This increased soil moisture in dry years could reduce losses of upland vegetation during drought years. Adverse effects on riparian and wetland communities and associated special-status plants could be substantial; thus, this impact would be significant.

This impact would be similar to Impact Bot-7 (CP1). The extent of the impact under CP2 would be greater than that under CP1. (The relative magnitude of changes to larger flows (which are most important for riparian and wetland vegetation) simulated for each alternative below Keswick Dam and RBPP are summarized on Figure 12-6.) This impact would be significant. Mitigation for this impact is proposed in Section 12.3.5, "Mitigation Measures."

Impact Bot-8 (CP2): Conflict with Approved Local or Regional Plans with Objectives of Riparian Habitat Protection or Watershed Management Numerous local and regional plans promote the conservation of riparian vegetation and associated habitats along the upper Sacramento River. Because CP2 would adversely affect riparian communities, this alternative could conflict with existing local and regional plans focused on preserving riparian habitats. Therefore, this impact would be potentially significant.

This impact would be the same as Impact Bot-8 (CP1), and would be potentially significant. Mitigation for this impact is proposed in Section 12.3.5, "Mitigation Measures."

Impact Bot-9 (CP2): Disturbance or Removal of Designated Critical Habitat for Special-Status Species Designated critical habitat for four vernal pool special-status plant species exists within the primary study area. However, critical habitat for vernal pool species is not expected to be adversely affected by CP2 because vernal pools are generally not present within the active floodplain. For this reason, this impact would be less than significant.

This impact would be similar to Impact Bot-9 (CP1). The extent of the impact under CP2 would be greater than that under CP1, CP4, and CP4A, but less than that under CP3 and CP5, which would entail greater alterations of flow regimes. For the same reasons as Impact Bot-9 (CP1), this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Bot-10 (CP2): Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Induced Growth Implementation of CP2 could increase water supplies for deliveries to water districts in the primary study area along the upper Sacramento River. This increase in water deliveries could reduce any limitation on urban growth and development that could affect sensitive plant communities and special-status plant species. However, this increase in water supplies for growth that could affect these resources would be small, and in the future the effects of this growth would be analyzed and mitigated during land use planning and environmental review for specific projects. For these reasons, this impact would be less than significant.

This impact would be similar to Impact Bot-10 (CP1). The extent of the impact under CP2 would be greater than that under CP1, CP4, and CP4A, but less than that under CP3 and CP5, which would result in a greater increase in water deliveries. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Bot-11 (CP2): Loss of Sensitive Natural Communities or Habitats Resulting from Implementing the Gravel Augmentation Program or Restoring Riparian, Floodplain, and Side Channel Habitats The proposed gravel augmentation program and riparian, floodplain, and side channel restoration activities would not be implemented under CP2. Therefore, no impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact Bot-12 (CP2): Loss of Special-Status Plants Resulting from Implementing the Gravel Augmentation Program or Restoring Riparian, Floodplain, and Side Channel Habitats The proposed gravel augmentation program and riparian, floodplain, and side channel restoration activities would not be implemented under CP2. Therefore, no impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact Bot-13 (CP2): Spread of Noxious and Invasive Weeds Resulting from Implementing the Gravel Augmentation Program or Restoring Riparian, Floodplain, and Side Channel Habitats The proposed gravel augmentation program and riparian, floodplain, and side channel restoration activities would not be implemented under CP2. Therefore, no impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta

Impact Bot-14 (CP2): Altered Structure and Species Composition and Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Altered Flow Regimes on the Lower Sacramento River Altered flow regimes associated with project implementation under CP2 could alter the structure and species composition or cause the loss of riparian, wetland, and oak communities, and of habitat for special-status plant species. Vernal pool plant communities and associated special-status plant species likely would not be affected. Effects on oak communities and upland habitats for special-status plants may not all be adverse. Adverse effects on riparian and wetland communities and associated special-status plants could be substantial on the lower Sacramento River, but these effects are unlikely to extend to the Delta; thus, for riparian and wetland communities and special-status plants, this impact would be significant on the lower Sacramento River, and less than significant in the Delta.

This impact would be similar to Impact Bot-14 (CP1). The extent of the impact under CP2 would be greater than that under CP1, CP4, and CP4A, but less than that under CP3 and CP5, which would entail more substantial alterations of flow regimes. (The relative magnitude of changes to larger flows (which are most important for riparian and wetland vegetation) simulated for each alternative below RBPP and Hamilton City are summarized on Figure 12-6.) Therefore, for riparian and wetland plant communities and associated special-status plant species on the lower Sacramento River, the impact would be significant, but in the Delta, the impact would be less than significant. Mitigation for this impact is proposed in Section 12.3.5, "Mitigation Measures."

Impact Bot-15 (CP2): Conflict with Approved Local or Regional Plans with Objectives of Riparian Habitat Protection or Watershed Management along the Lower Sacramento River Adopted local and regional plans address and promote the conservation of riparian vegetation and associated habitats along the lower Sacramento River. Because CP2 would adversely affect riparian communities, this alternative could conflict with existing local and regional plans focused on preserving riparian habitats. Therefore, this impact would be potentially significant.

This impact would be the same as Impact Bot-15 (CP1) and would be potentially significant. Mitigation for this impact is proposed in Section 12.3.5, "Mitigation Measures."

Impact Bot-16 (CP2): Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Induced Growth along the Lower Sacramento River and in the Delta Implementation of CP2 could increase water supplies for deliveries to water districts in the extended study area along the lower Sacramento River. This increase in water deliveries could reduce any limitation on urban growth and development that could affect sensitive plant communities and special-status plant species. However, this increase in water supplies for growth that could affect these resources would be small, and in the future the effects of this growth would be analyzed and mitigated during land use planning and environmental review for specific projects. For these reasons, this impact would be less than significant.

This impact would be similar to Impact Bot-16 (CP1). The extent of the impact under CP2 would be greater than that under CP1, CP4, and CP4A, but less than that under CP3 and CP5, which would result in greater increases in water deliveries. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CVP/SWP Service Areas

Impact Bot-17 (CP2): Altered Structure and Species Composition and Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Altered Flow Regimes in the CVP/SWP Service Areas Altered flow regimes associated with project implementation under CP2 could alter the structure and species composition or cause the loss of sensitive plant communities and of habitat for special-status plant species. However, alteration of flow regimes below CVP and SWP reservoirs in the extended study area would be less than below Shasta Dam along the upper and lower Sacramento River. These alterations may not be sufficient to affect the extent of early-successional riparian and wetland communities or of associated habitats for special-status plant species. Therefore, below CVP and SWP reservoirs in the extended study area, this impact would be less than significant.

This impact would be similar to Impact Bot-17 (CP1). The extent of the impact under CP2 would be greater than that under CP1, CP4, and CP4A, but less than that under CP3 and CP5, which would entail more substantial alterations of flow regimes. Nonetheless, for the same reasons as Impact Bot-17 (CP1), this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Bot-18 (CP2): Conflict with Approved Local or Regional Plans with Objectives of Riparian Habitat Protection or Watershed Management in the CVP/SWP Service Areas Adopted local and regional plans address and promote the conservation of riparian vegetation and associated habitats along rivers below reservoirs in the CVP and SWP service areas. However, implementation of CP2 would not cause a significant impact on riparian vegetation and habitats. Therefore, CP2 would not conflict with existing local and regional plans focused on preserving riparian habitats. Thus, in the CVP and SWP service areas, this impact would be less than significant.

This impact would be to the same as Impact Bot-18 (CP1); the impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Bot-19 (CP2): Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Induced Growth in the CVP/SWP Service Areas Implementation of CP2 could increase water supplies for deliveries to water districts in the CVP and SWP service areas. This increase in water deliveries could reduce a limitation on growth that could affect sensitive plant communities and special-status plant species. However, this increase in water supplies for growth that could affect these resources would be small, and in the future the effects of this growth would be analyzed and mitigated during land use planning and environmental review for specific projects. For these reasons, this impact would be less than significant.

This impact would be similar to Impact Bot-19 (CP1). The extent of the impact under CP2 would be greater than that under CP1, CP4, and CP4A, but less than that under CP3 and CP5, which would result in greater increases in water deliveries. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CP3 – 18.5-Foot Dam Raise, Agricultural Water Supply Reliability and Anadromous Fish Survival

CP3 focuses on increasing agricultural water supply reliability while also increasing anadromous fish survival. This plan primarily consists of raising Shasta Dam by 18.5 feet, which, in combination with spillway modifications, would increase the height of the reservoir's full pool by 20.5 feet and enlarge the total storage capacity in the reservoir by 634,000 acre-feet. The existing TCD would also be extended to achieve efficient use of the expanded cold-water pool. Because CP3 focuses on increasing agricultural water supply reliability, none of the increased storage capacity in Shasta Reservoir would be reserved for increasing M&I deliveries. Operations for water supply, hydropower, and environmental and other regulatory requirements would be similar to existing operations, with the additional storage retained for water supply reliability and to expand the cold-water pool for downstream anadromous fisheries.

Simulations of CP3 did not involve any changes to the modeling logic for deliveries or flow requirements; all rules for water operations were updated to include the new storage, but were not otherwise changed.

The botany and wetland impact analysis previously presented for CP1 assumes maximum vegetation clearing within the relocation areas. Vegetation clearing impacts within the relocation areas under CP3 would be greater than under CP1 and CP2, but would not exceed those acreages of impacts presented under CP1.

Shasta Lake and Vicinity

Impact Bot-1 (CP3): Loss of Federally or State-Listed Plant Species Habitat for Federally or State-listed plant species does not occur at Shasta Lake or in the vicinity. No species are known or expected to occur. Therefore, no impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact Bot-2 (CP3): Loss of MSCS Covered Species Implementation of the project would result in the loss of MSCS covered species because of inundation, vegetation removal, or construction activities. Therefore, this impact would be significant. Impacts related to dam construction and vegetation clearing within the relocation areas would be similar to but greater than CP2. However, inundation caused by an 18.5-foot raise of Shasta Dam would affect all or portions of eleven Shasta snow-wreath populations. These eleven populations represent 46 percent of all known Shasta snow-wreath populations and encompass approximately 79 acres. Flooding impacts under CP2 would result in the loss of approximately 2.6 acres, or approximately 3 percent of these eleven Shasta snow-wreath populations. The greatest proportional impacts to these populations occur at the Blue Ridge West, Brock Creek, Cove Creek, Keluche Creek, and Shasta Caverns populations. Table 12-22 provides a detailed summary of impacts to Shasta snow-wreath under CP3. Mitigation measures for impacts to Shasta snow-wreath populations are presented in Section 12.3.5, "Mitigation Measures."

Table 12-22. Summary of Impacts to Shasta Snow-Wreath Populations Adjacent to Shasta Lake Under CP3

Population	Location	Size (Acres)	CP3 Impact (Acres)	Percent Total Impact to Population	Comments
Blue Ridge (west)	Main Body	1.11	0.750	68%	Lower portion of population would be flooded.
Blue Ridge (east)	Main Body	0.03	0.002	7%	Lower portion of population would be flooded.
Brock Creek	Pit River Arm	1.38	0.634	46%	Nearly half of the population would be flooded.
Campbell Creek	McCloud River Arm	1.90	0.036	2%	Small area at the downstream portion of the population would be flooded.
Cove Creek	Main Body	1.87	0.401	21%	Lower portion of population would be flooded.
Ellery Creek	McCloud River Arm	28.65	0.047	<1%	The entire very small disjunct sub-population located near Ellery Creek Campground would be flooded.
Jones Valley	Main Body	0.33	0.015	4%	Nearly all of both small disjunct sub-populations at the lower portion of the population would be flooded.
Keluche Creek	McCloud River Arm	0.15	0.146	95%	Nearly all of the population would be flooded.
Shasta Caverns	McCloud River Arm	0.08	0.018	21%	Lower portion of population would be flooded.
South of Cove Creek	Main Body	1.39	0.149	11%	Lower portion of population would be flooded.
Stein Creek	Pit River Arm	42.15	0.469	1%	Lower portion of population would be flooded.

Key:
% = percent
< = less than
CP = Comprehensive Plan

Impacts related to dam construction and vegetation clearing or other construction activities within the relocation areas would be similar to but greater than CP2. However, inundation caused by an 18.5-foot raise of Shasta Dam could result in the loss of more individual plants or plant populations, and their habitat.

This impact would be significant. Mitigation for this impact is described in Section 12.3.5, "Mitigation Measures."

Impact Bot-3 (CP3): Loss of USFS Sensitive, BLM Sensitive, or CRPR Species
Implementation of the project would result in the loss of USFS sensitive, BLM sensitive, or CRPR species because of inundation, vegetation removal, or construction activities. Therefore, this impact would be potentially significant.

Impacts related to dam construction and vegetation clearing within the relocation areas would be similar to but greater than CP2. However, inundation caused by an 18.5-foot raise of Shasta Dam could result in the loss of more individual plants.

Impacts to Shasta County arnica and Shasta limestone monkeyflower populations resulting from CP3 are similar to those described for CP2; however, CP3 would impact four Cantelow's lewisia populations, two northern clarkia populations, and 99 slender false lupine populations. Impacts to Shasta huckleberry resulting from CP3 are the same as those described for CP1.This impact would be significant. Mitigation for this impact is described in Section 12.3.5, "Mitigation Measures."

Impact Bot-4 (CP3): Loss of Jurisdictional Waters Implementation of the project will result in the loss of jurisdictional waters caused by flooding the impoundment area and discharge of fill associated with the relocation of facilities and dam construction. Flooding caused by implementation of the project would result in the conversion of jurisdictional water types (e.g., wetlands and streams to lacustrine habitat). Therefore, this impact would be significant.

Direct impacts would incur by conversion of jurisdictional waters (e.g., wetlands and streams) to lacustrine habitat with implementation of CP3. All features within the impoundment area would be converted to lacustrine habitat. Under CP3, approximately 31 acres of wetlands and 49 acres of other waters would be converted to lacustrine habitat (Table 12-23). This will result in a net loss of approximately 31 acres of wetlands and loss of approximately 49 acres of riverine waters by conversion to lacustrine waters. The impacts associated with relocation are the same as Impact Bot-4, CP1 as shown on Table 12-16. The relocation impacts to wetlands would result in the loss of approximately 2.3 acres of wetlands and 1.6 acres of other waters.

The impact would be significant. Mitigation for this impact is proposed in Section 12.3.5, "Mitigation Measures."

Table 12-23. Impacts to Jurisdictional Waters (Acres[1]) in the Impoundment Area (18.5-Foot Dam Raise)

Jurisdictional Water Type	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Wetlands							
Fresh emergent/ riparian wetland	0.00	0.00	5.30	0.00	0.00	0.00	5.30
Intermittent swale	0.00	0.00	0.00	0.00	0.00	0.04	0.04
Riparian wetland	1.09	1.73	7.05	8.33	1.49	0.77	20.46
Seasonal wetland	0.00	0.00	0.42	0.00	0.14	0.02	0.58
Seep/spring wetland	0.77	0.23	0.80	0.41	0.16	0.47	2.84
Vegetated ditch	0.13	0.00	0.00	0.02	0.00	0.00	0.15
Total Wetlands	1.99	1.96	13.57	8.76	1.79	1.30	29.37
Other Waters of the United States							
Ephemeral stream	0.28	0.01	0.62	0.28	0.13	0.12	1.44
Intermittent stream	1.42	0.24	2.42	0.91	0.92	2.58	8.50
Perennial stream	1.55	3.00	9.78	20.27	2.39	1.57	38.56
Roadside ditch	0.00	0.00	0.01	0.00	0.00	0.00	0.01
Seep/spring other waters	0.03	0.00	0.001	0.01	0.00	0.00	0.04
Total Other Waters	3.28	3.25	12.83	21.47	3.44	4.27	48.54
Total	5.27	5.21	26.40	30.23	5.23	5.57	77.91

Note:
[1] Acreage values are approximate

Impact Bot-5 (CP3): Loss of General Vegetation Habitats Implementation of the project would result in a loss of general vegetation habitats because of inundation, vegetation removal, or construction activities. Therefore, this impact would be potentially significant.

Under CP3, 2,492 acres of general vegetation habitats will be directly impacted by the inundation of the impoundment area (Table 12-24).

The impact would be potentially significant. Mitigation for this impact is proposed in Section 12.3.5, "Mitigation Measures."

Table 12-24. Impacts to CWHR Habitats (Acres[1]) in the Impoundment Area (18.5-Foot Dam Raise)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Annual grassland	0.44	0.00	3.10	0.70	0.00	0.00	4.23
Barren	2.30	0.00	10.60	3.56	0.00	4.13	20.59
Blue oak – foothill pine	10.36	0.00	0.00	0.00	4.29	6.81	21.46
Blue oak woodland	0.00	0.00	0.00	0.00	0.00	1.94	1.94
Closed-cone pine – cypress	32.68	0.00	12.95	20.89	44.72	373.48	484.73
Douglas-fir	0.00	0.00	0.00	0.36	0.00	0.00	0.36
Mixed chaparral	29.19	13.64	161.04	15.14	10.35	59.50	288.87
Montane hardwood	73.49	38.76	171.01	70.36	19.43	2.49	375.56
Montane hardwood – conifer	70.68	0.99	150.42	136.53	111.63	10.55	480.83
Montane riparian	4.16	6.67	26.16	13.91	1.53	1.57	54.00
Ponderosa pine	215.11	30.72	188.21	161.64	49.56	57.50	702.74
Riverine	0.00	0.88	5.24	15.43	1.41	0.00	22.96
Urban	21.95	0.00	1.95	7.96	0.00	1.92	33.80
Total	460.37	91.67	730.68	446.48	242.92	519.89	2492.07

Note:
[1] Acreage values are approximate.
Key:
CWHR = California Wildlife Habitat Relationship

Impact Bot-6 (CP3): Spread of Noxious and Invasive Weeds Implementation of the project could result in the spread of noxious and invasive weeds because of ground-disturbing activities during construction and an increased number of vectors (means of dispersal). Therefore, this impact would be potentially significant.

Impacts resulting from the spread of noxious weeds under CP3 are anticipated to be similar to, but greater than, those described for CP1. Therefore, this impact would be potentially significant. Mitigation for this impact is proposed in Section 12.3.5, "Mitigation Measures."

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact Bot-7 (CP3): Altered Structure and Species Composition and Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Altered Flow Regimes Altered flow regimes associated with project implementation under CP3 could alter the structure and species composition or cause the loss of riparian, wetland, and oak communities, and of habitat for special-status plant species. Vernal pool plant communities and associated special-status species likely would not be affected. Effects on oak communities and upland habitats for special-status plants may not all be adverse. Adverse effects on riparian and wetland communities and associated special-status plants could be substantial; thus, this impact would be significant.

This impact would be similar to Impact Bot-7 (CP1). The extent of the impact would be greater under CP3 than under CP2. (The relative magnitude of changes to larger flows (which are most important for riparian and wetland vegetation) simulated for each alternative below Keswick Dam and RBPP are summarized on Figure 12-6.) This impact would be significant. Mitigation for this impact is proposed in Section 12.3.5, "Mitigation Measures."

Impact Bot-8 (CP3): Conflict with Approved Local or Regional Plans with Objectives of Riparian Habitat Protection or Watershed Management Numerous local and regional plans address and promote the conservation of riparian vegetation and associated habitats along the upper Sacramento River. Because CP3 would adversely affect riparian communities, this alternative could conflict with existing local and regional plans focused on preserving riparian habitats. Therefore, this impact would be potentially significant.

This impact would be the same as Impact Bot-8 (CP1) and would be potentially significant. Mitigation for this impact is proposed in Section 12.3.5, "Mitigation Measures."

Impact Bot-9 (CP3): Disturbance or Removal of Designated Critical Habitat for Special-Status Species Designated critical habitat for four vernal pool special-status plant species exists within the primary study area. However, such critical habitat is not expected to be adversely affected by CP3. For this reason, this impact would be less than significant.

This impact would be similar to Impact Bot-9 (CP1). The extent of the impact would be greater than under CP1, CP2, CP4, and CP4A, but less than under CP5, which would entail a greater alteration of flow regimes. However, for the same reasons as Impact Bot-9 (CP1), this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Bot-10 (CP3): Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Induced Growth Implementation of CP3 could increase water supplies for deliveries to water districts in the primary study area along the upper Sacramento River. This increase in water deliveries could reduce a limitation on growth that could affect sensitive plant communities and special-status plant species. However, this increase in water supplies for growth that could affect these resources would be small, and in the future the effects of this growth would be analyzed and mitigated during land use planning and environmental review for specific projects. For these reasons, this impact would be less than significant.

This impact would be similar to Impact Bot-10 (CP1). The extent of the impact would be greater under CP3 than under CP1, CP2, CP4, and CP4A, but less than under CP5, which would result in a greater increase in water deliveries. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Bot-11 (CP3): Loss of Sensitive Natural Communities or Habitats Resulting from Implementing the Gravel Augmentation Program or Restoring Riparian, Floodplain, and Side Channel Habitats The proposed gravel augmentation program and riparian, floodplain, and side channel restoration activities would not be implemented under CP3. Therefore, no impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact Bot-12 (CP3): Loss of Special-Status Plants Resulting from Implementing the Gravel Augmentation Program or Restoring Riparian, Floodplain, and Side Channel Habitats The proposed gravel augmentation program and riparian, floodplain, and side channel restoration activities would not be implemented under CP3. Therefore, no impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact Bot-13 (CP3): Spread of Noxious and Invasive Weeds Resulting from Implementing the Gravel Augmentation Program or Restoring Riparian, Floodplain, and Side Channel Habitats The proposed gravel augmentation program and riparian, floodplain, and side channel restoration activities would not be implemented under CP3. Therefore, no impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta

Impact Bot-14 (CP3): Altered Structure and Species Composition and Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Altered Flow Regimes on the Lower Sacramento River Altered flow regimes associated with project implementation under CP3 could alter the structure and species composition or cause the loss of riparian, wetland, and oak communities, and of habitat for special-status plant species. Vernal pool plant communities and associated special-status plant species likely would not be affected. Effects on oak communities and upland habitats for special-status plants may not all be adverse. Adverse effects on riparian and wetland communities and associated special-status plants could be substantial on the lower Sacramento River, but these effects are unlikely to extend to the Delta; thus, for riparian and wetland communities and special-status plants, this impact would be significant on the lower Sacramento River, and less than significant in the Delta.

This impact would be similar to Impact Bot-14 (CP1). The extent of the impact would be greater under CP3 than under CP1, CP2, CP4, and CP4A, but would be less than under CP5, which would entail more substantial alterations of flow regimes. (The relative magnitude of changes to larger flows (which are most important for riparian and wetland vegetation) simulated for each alternative below RBPP and Hamilton City are summarized on Figure 12-6.) This impact would be significant on the lower Sacramento River and less than significant in the Delta. Mitigation for this impact on the lower Sacramento River is proposed in Section 12.3.5, “Mitigation Measures.”

Impact Bot-15 (CP3): Conflict with Approved Local or Regional Plans with Objectives of Riparian Habitat Protection or Watershed Management along the Lower Sacramento River Adopted local and regional plans address and promote the conservation of riparian vegetation and associated habitats along the lower Sacramento River in the extended study area. Because CP3 would adversely affect riparian communities, this alternative could conflict with existing local and regional plans focused on preserving riparian habitats. Therefore, this impact would be potentially significant.

This impact would be the same as Impact Bot-15 (CP1) and would be potentially significant. Mitigation for this impact is proposed in Section 12.3.5, "Mitigation Measures."

Impact Bot-16 (CP3): Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Induced Growth along the Lower Sacramento River and in the Delta Implementation of CP3 could increase water supplies for deliveries to water districts in the extended study area along the lower Sacramento River. This increase in water deliveries could reduce any limitation on growth that could affect sensitive plant communities and special-status plant species. However, this increase in water supplies for growth that could affect these resources would be small, and in the future the effects of this growth would be analyzed and mitigated during land use planning and environmental review for specific projects. For these reasons, this impact would be less than significant.

This impact would be similar to Impact Bot-16 (CP1). The extent of the impact under CP3 would be greater than under CP1, CP2, CP4, and CP4A, but less than that under CP5, which would result in a greater increase in water deliveries. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CVP/SWP Service Areas

Impact Bot-17 (CP3): Altered Structure and Species Composition and Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Altered Flow Regimes in the CVP/SWP Service Areas Altered flow regimes associated with project implementation under CP3 could alter the structure and species composition or cause the loss of sensitive plant communities and of habitat for special-status plant species. However, alteration of flow regimes below CVP and SWP reservoirs in the extended study area would be less than below Shasta Dam along the upper and lower Sacramento River. These alterations may not be sufficient to alter the extent of early-successional riparian and wetland communities or associated habitats for special-status plant species. Therefore, this impact would be less than significant.

This impact would be similar to Impact Bot-17 (CP1). The extent of the impact would be greater under CP3 than under CP1, CP2, CP4, and CP4A, but less than that under CP5, which would entail more substantial alterations of flow regimes. Nonetheless, for the same reasons as Impact Bot-17 (CP1), this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Bot-18 (CP3): Conflict with Approved Local or Regional Plans with Objectives of Riparian Habitat Protection or Watershed Management in the CVP/SWP Service Areas Adopted local and regional plans address and promote the conservation of riparian vegetation and associated habitats along rivers below reservoirs in the CVP and SWP service areas. However, implementation of CP3 would not cause a significant impact on riparian vegetation and habitats. Therefore, CP3 would not conflict with existing local and regional plans focused on preserving riparian habitats. Thus, this impact would be less than significant.

This impact would be the same as Impact Bot-18 (CP1) and would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Bot-19 (CP3): Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Induced Growth in the CVP/SWP Service Areas Implementation of CP3 could increase water supplies for deliveries to water districts in the extended study area in the CVP and SWP service areas. This increase in water deliveries could reduce a limitation on growth that could affect sensitive plant communities and special-status plant species. However, this increase in water supplies for growth that could affect these resources would be small, and in the future the effects of this growth would be analyzed and mitigated during land use planning and environmental review for specific projects. For these reasons, this impact would be less than significant.

This impact would be similar to Impact Bot-19 (CP1). The extent of the impact under CP3 would be greater than that under CP1, CP2, CP4, and CP4A, but less than that under CP5, which would result in a greater increase in water deliveries. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CP4 and CP4A – 18.5-Foot Dam Raise, Anadromous Fish Focus with Water Supply Reliability

CP4 and CP4A focus on increasing anadromous fish survival while also increasing water supply reliability. By raising Shasta Dam 18.5 feet, in combination with spillway modifications, CP4 or CP4A would increase the height of the reservoir full pool by 20.5 feet and enlarge the total storage capacity in the reservoir by 634,000 acre-feet. The existing TCD would also be extended to achieve efficient use of the expanded cold-water pool. The additional storage created by the 18.5-foot dam raise would be used to improve the ability to meet temperature objectives and habitat requirements for anadromous fish during drought years and increase water supply reliability. CP4A is identical to CP4 with the exception of Shasta Dam and reservoir operations. CP4 and CP4A have similar reservoir operations in that they each dedicate a portion of the new storage in Shasta Lake for fisheries purposes; however, the portion of this dedicated storage varies.

For CP4, about 378,000 acre-feet of the increased reservoir storage space would be dedicated to increasing the supply of cold water for anadromous fish survival purposes. Operations for the remaining portion of increased storage (approximately 256,000 acre-feet) would be the same as in CP1, with 70,000 acre-feet and 35,000 acre-feet reserved to specifically focus on increasing M&I deliveries during dry and critical years, respectively.

For CP4A, about 191,000 acre-feet of the increased reservoir storage space would be dedicated to increasing the supply of cold water for anadromous fish survival purposes. For CP4A, operations for the remaining portion of increased storage (approximately 443,000 acre-feet) would be the same as in CP2, with 120,000 acre-feet reserved in dry years and 60,000 acre-feet reserved in critical years to specifically focus on increasing M&I deliveries.

CP4 and CP4A also include augmenting spawning gravel and restoring riparian, floodplain, and side channel habitat in the upper Sacramento River. Gravel placement would occur at one or more sites per year over a 10-year period and would be accomplished by one of three methods: lateral berms, talus cone, or direct placement in river, as appropriate, depending on specific conditions, including geomorphology, of the augmentation site. To the extent available, existing river access points would be used to deliver gravel to the river; however, temporary new access roads would be needed in some cases, mostly adjacent to the river. In addition, riparian, floodplain, and side channel habitat restoration would be constructed at up to six sites identified along the upper Sacramento River: Henderson Open Space, Tobiasson Island, Shea Island Complex, Kapusta Island, Anderson River Park, and Reading Island. These restoration projects could involve some vegetation clearing.

Impacts under CP4 or CP4A associated with vegetation clearing within the relocation areas would be the same under CP3. However, additional vegetation clearing would result under CP4 or CP4A as a result of clearing to access gravel augmentation sites and to construct the identified riparian, floodplain, and side channel restoration projects.

Shasta Lake and Vicinity

Impact Bot-1 (CP4 and CP4A): Loss of Federally or State-Listed Plant Species

Habitat for Federally or State-listed plant species does not occur at Shasta Lake or in the vicinity. No species are known or expected to occur. Therefore, no impact would occur for CP4 or CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact Bot-2 (CP4 and CP4A): Loss of MSCS Covered Species

Implementation of the project would result in the loss of MSCS covered species as a result of inundation, vegetation removal, or construction activities. Therefore, this impact would be significant for CP4 or CP4A.

This impact would be similar to Impact Bot-2 (CP3). This impact would be significant for CP4 or CP4A. Mitigation for this impact is proposed in Section 12.3.5, “Mitigation Measures.”

Impact Bot-3 (CP4 and CP4A): Loss of USFS Sensitive, BLM Sensitive, or CRPR Species Implementation of the project would result in the loss of USFS sensitive, BLM sensitive, or CRPR species as a result of inundation, vegetation removal, or construction activities. Therefore, this impact would be potentially significant for CP4 or CP4A.

This impact would be similar to Impact Bot-3 (CP3) and would be potentially significant for CP4. Mitigation for this impact is proposed in Section 12.3.5, “Mitigation Measures.”

This impact would be similar to Impact Bot-3 (CP3) and would be potentially significant for CP4A. Mitigation for this impact is proposed in Section 12.3.5, “Mitigation Measures.”

Impact Bot-4 (CP4 and CP4A): Loss of Jurisdictional Waters Implementation of the project would result in the loss of jurisdictional waters because of flooding of the impoundment area and fill associated with the relocation of facilities and dam construction. Flooding caused by implementation of the project would result in the conversion of jurisdictional water types (e.g., wetlands and streams to lacustrine habitat). Therefore, this impact would be significant for CP4 or CP4A.

This impact would be similar to Impact Bot-4 (CP3) and would be significant for CP4. Mitigation for this impact is proposed in Section 12.3.5, “Mitigation Measures.”

This impact would be similar to Impact Bot-4 (CP3) and would be significant for CP4A. Mitigation for this impact is proposed in Section 12.3.5, “Mitigation Measures.”

Impact Bot-5 (CP4 and CP4A): Loss of General Vegetation Habitats Implementation of the project would result in a loss of general vegetation habitats because of inundation, vegetation removal, or construction activities.

This impact would be similar to Impact Bot-5 (CP3) and would be potentially significant for CP4. Mitigation for this impact is proposed in Section 12.3.5, “Mitigation Measures.”

This impact would be similar to Impact Bot-5 (CP3) and would be potentially significant for CP4A. Mitigation for this impact is proposed in Section 12.3.5, “Mitigation Measures.”

Impact Bot-6 (CP4 and CP4A): Spread of Noxious and Invasive Weeds
Implementation of the project could result in the spread of noxious and invasive weeds as a result of ground-disturbing activities during construction and an increased number of vectors (means of dispersal). This impact would be potentially significant for CP4 or CP4A.

Impacts resulting from the spread of noxious weeds under CP4 are anticipated to be similar to those described for CP3. This impact would be potentially significant for CP4. Mitigation for this impact is proposed in Section 12.3.5, "Mitigation Measures."

Impacts resulting from the spread of noxious weeds under CP4A are anticipated to be similar to those described for CP3. This impact would be potentially significant for CP4A. Mitigation for this impact is proposed in Section 12.3.5, "Mitigation Measures."

Upper Sacramento River (Shasta Dam to Red Bluff)
Impact Bot-7 (CP4 and CP4A): Altered Structure and Species Composition and Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Altered Flow Regimes Altered flow regimes associated with project implementation under CP4 or CP4A, could alter the structure and species composition or cause the loss of riparian, wetland, and oak communities, and habitat for special-status plant species. Vernal pool plant communities and associated special-status species likely would not be affected. Effects on oak communities and upland habitats for special-status plants may not all be adverse. Adverse effects on riparian and wetland communities and associated special-status plants could be substantial; thus, for riparian and wetland communities and special-status plants, this impact would be significant.

This impact would be the same as Impact Bot-7 (CP1) and would be significant for CP4. Mitigation for this impact is proposed in Section 12.3.5, "Mitigation Measures."

This impact would be similar to Impact Bot-7 (CP1), but greater as in Impact Bot-7 (CP2) due to more substantial alterations of flow regimes for CP4A. This impact would be significant for CP4A. Mitigation for this impact is proposed in Section 12.3.5, "Mitigation Measures."

Impact Bot-8 (CP4 and CP4A): Conflict with Approved Local or Regional Plans with Objectives of Riparian Habitat Protection or Watershed Management Numerous local and regional plans address and promote the conservation of riparian vegetation and associated habitats along the upper Sacramento River. Because CP4 or CP4A would adversely affect riparian communities, this alternative could conflict with existing local and regional plans focused on preserving riparian habitats. Therefore, this impact would be potentially significant for CP4 or CP4A.

This impact would be the same as Impact Bot-8 (CP1) and would be potentially significant for CP4. Mitigation for this impact is proposed in Section 12.3.5, “Mitigation Measures.”

This impact would be the same as Impact Bot-8 (CP1) and would be potentially significant for CP4A. Mitigation for this impact is proposed in Section 12.3.5, “Mitigation Measures.”

Impact Bot-9 (CP4 and CP4A): Disturbance or Removal of Designated Critical Habitat for Special-Status Species Designated critical habitat for four vernal pool special-status plant species exists within the primary study area. However, such critical habitat is not expected to be adversely affected by CP4 or CP4A. This impact would be less than significant for CP4 or CP4A.

This impact would be the same as Impact Bot-9 (CP1) and would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

This impact would be similar to Impact Bot-9 (CP1), but greater, as in Impact Bot-9 (CP2) for CP4A. The extent of the impact under CP4A would be greater than that under CP1 and CP4, but less than that under CP3 and CP5, which would entail greater alterations of flow regimes. For the same reasons as Impact Bot-9 (CP2), this impact would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact Bot-10 (CP4 and CP4A): Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Induced Growth Implementation of CP4 or CP4A could increase water supplies for deliveries to water districts in the primary study area along the upper Sacramento River. This increase in water deliveries could reduce a limitation on growth that could affect sensitive plant communities and special-status plant species. However, this increase in water supplies for growth that could affect these resources would be small, and in the future the effects of this growth would be analyzed and mitigated during land use planning and environmental review for specific projects. For these reasons, this impact would be less than significant for CP4 or CP4A.

This impact would be the same as Impact Bot-10 (CP1) and would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

This impact would be similar to Impact Bot-10 (CP1), but greater, as in Impact Bot-10 (CP2). The extent of the impact under CP4A would be greater than that under CP1 and CP4, but less than that under CP3 and CP5, which would result in a greater increase in water deliveries. This impact would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact Bot-11 (CP4 and CP4A): Loss of Sensitive Natural Communities or Habitats Resulting from Implementing the Gravel Augmentation Program or

Restoring Riparian, Floodplain, and Side Channel Habitats Implementation of the gravel augmentation program could result in the removal of riparian and wetland vegetation or the degradation of riparian and wetland habitats, including wetlands qualifying as waters of the United States. In addition, actions to restore riparian, floodplain, and side channel habitats would remove riparian vegetation, and could result in discharge of fill material into waters of the United States. This impact would be potentially significant for CP4 or CP4A.

A gravel augmentation program would be implemented under CP4 or CP4A, as described in Chapter 2, “Alternatives.” Gravel placement falls under Nationwide Permit (NWP) 27, “Aquatic Habitat Restoration, Establishment, and Enhancement.” Activities qualifying for NWPs have been determined by USACE to have no more than minimal adverse effects on the aquatic environment (72 Federal Register 11092). Therefore, the direct placement of gravel into the Sacramento River would not be considered a significant impact on waters of the United States. No vernal pools or other seasonal wetlands are present at any of the proposed augmentation sites. However, gravel augmentation could result in removal of riparian vegetation during construction of access routes to the gravel placement sites. To the extent feasible, existing access roads would be used, but access to some of the proposed placement sites does not currently exist. Clearing and grubbing would be needed to create access to these gravel placement sites, and in some areas, vegetation clearing along banks would be used to allow gravel to fall easily from the banks into the river. These activities could result in removal of riparian vegetation.

In addition, actions would be implemented to restore riparian, floodplain, and side channel habitats by increasing connectivity between the Sacramento River and one or more side channels at the potential downstream Sacramento River restoration sites. As described in Chapter 2, “Alternatives,” these actions would involve excavation and grading to modify side channel and adjacent floodplain topography, and subsequent revegetating of disturbed floodplain with native riparian vegetation. This is expected to provide a beneficial effect on floodplain and riparian habitat along these side channels. However, some construction activities associated with restoring river connectivity or removing or rehabilitating existing facilities could result in the long-term removal of riparian vegetation. See Table 12-25 for a summary of the potential impacts to plant communities and see Table 12-26 for potential impacts to jurisdictional waters.

Table 12-25. Summary of Potential Impacts to Plant Communities in the Potential Sacramento River Downstream Restoration Areas

Habitat	Area (Acres[1])					
	Henderson	Tobiasson Island	Shea Island Complex	Kapusta Island	Anderson River Park	Reading Island
N/A Broom patches	N/A	0.570	2.532	0.275	N/A	N/A
Black locust groves	N/A	N/A	N/A	N/A	N/A	N/A
California annual grassland	N/A	1.282	N/A	1.671	0.004	N/A
California yerba santa scrub	N/A	0.001	N/A	N/A	N/A	N/A
Cattail marshes	0.194	N/A	0.185	N/A	N/A	N/A
Foothill pine	N/A	0.718	N/A	0.276	N/A	N/A
Fremont cottonwood forest	1.137	N/A	N/A	0.384	0.223	N/A
Hind's walnut stands	N/A	N/A	N/A	N/A	N/A	N/A
Orchard	N/A	N/A	N/A	N/A	N/A	0.002
Oregon ash groves	N/A	N/A	N/A	N/A	N/A	N/A
Sandbar willow thickets	0.326	0.331	0.294	0.322	0.291	0.149
Shining willow groves	N/A	0.060	0.285	N/A	N/A	N/A
Silver wattle thickets	N/A	N/A	N/A	N/A	N/A	N/A
Soft rush marshes	N/A	N/A	N/A	N/A	N/A	N/A
Valley oak woodland	0.146	0.083	0.239	N/A	0.115	2.552
Wright's buckwheat patches	N/A	N/A	N/A	N/A	N/A	N/A
Water primrose wetlands	0.649	N/A	N/A	N/A	4.251	13.696
White alder groves	N/A	N/A	0.190	N/A	N/A	N/A
White-root beds	N/A	N/A	N/A	0.084	N/A	N/A
Mixed riparian forest	N/A	N/A	N/A	N/A	N/A	5.62
Parrot's feather mats	N/A	N/A	N/A	N/A	1.599	N/A
Reed canarygrass swards	N/A	N/A	N/A	N/A	0.899	N/A
Barren[2]	N/A	N/A	N/A	N/A	N/A	N/A
Riverine[2]	0.100	0.024	N/A	N/A	N/A	0.315

Note:
[1] Acreage values are approximate
[2] CWHR Wildlife Habitat Type; no corresponding plant series type included in A Manual of California Vegetation (Sawyer and Keeler-Wolf 1995).

Key:
N/A = not applicable

Table 12-26. Potential Impacts to Jurisdictional Waters in the Potential Sacramento River Downstream Restoration Areas

Jurisdictional Water Type	Area (Acres[1])					
	Henderson Open Space	Tobiasson Island	Shea Island Complex	Kapusta Island	Anderson River Park	Reading Island
Wetlands						
Fresh emergent wetland	0.160	N/A	0.368	N/A	5.419	7.241
Riparian wetland	0.128	0.101	0.292	0.084	1.857	5.466
Riparian/fresh emergent wetland complex	N/A	N/A	N/A	N/A	1.591	N/A
Other Waters of the United States						
Ephemeral stream	N/A	N/A	N/A	N/A	N/A	N/A
Intermittent stream	N/A	N/A	N/A	N/A	N/A	N/A
Perennial stream	0.163	0.107	2.389	0.048	0.073	6.512
Pond	0.900	N/A	N/A	N/A	N/A	N/A

Note:
[1]Acreage values are approximate.
Key:
N/A = not applicable

Modification of side channels and the side-channel openings connecting them to the Sacramento River would fall under NWP 27, "Aquatic Habitat Restoration, Establishment, and Enhancement." The potential relocation or rehabilitation of the existing power line and poles at the Henderson Open Space and of the existing boat ramp at Reading Island would also qualify for an NWP. Activities qualifying for NWPs have been determined by USACE to have no more than minimal adverse effects on the aquatic environment (72 Federal Register 11092). Although the activities described above would not have a significant impact on waters of the United States, implementation of the gravel augmentation program and riparian, floodplain, and side channel habitat restoration at up to six sites, would have a potentially significant impact on sensitive natural communities for CP4. Mitigation for this impact is proposed in Section 12.3.5, "Mitigation Measures."

Although the activities described above would not have a significant impact on waters of the United States, implementation of the gravel augmentation program and riparian, floodplain, and side channel habitat restoration at up to six sites, would have a potentially significant impact on sensitive natural communities for CP4A. Mitigation for this impact is proposed in Section 12.3.5, "Mitigation Measures."

Impact Bot-12 (CP4 and CP4A): Loss of Special-Status Plants Resulting from Implementing the Gravel Augmentation Program or Restoring Riparian, Floodplain, and Side Channel Habitats The gravel augmentation program would involve vegetation removal and gravel placement that could result in the loss of special-status plants if they are present at the gravel placement sites. Similarly, restoring riparian, floodplain, and side channel habitats would involve excavation, grading, and vegetation clearing that could result in the loss of special-status plants if they are present at the restoration sites. This impact would be potentially significant for CP4 or CP4A.

Special-status plant species could be killed during vegetation clearing and grubbing or gravel placement if they are present at the gravel placement sites or areas that would be cleared for access. Similarly, special-status plants could be killed during vegetation clearing, excavation, and grading if they are present at the riparian, floodplain, and side channel restoration sites or areas disturbed for access.

The impact would be potentially significant for CP4. Mitigation for this impact is proposed in Section 12.3.5, "Mitigation Measures."

The impact would be potentially significant for CP4A. Mitigation for this impact is proposed in Section 12.3.5, "Mitigation Measures."

Impact Bot-13 (CP4 and CP4A): Spread of Noxious and Invasive Weeds Resulting from Implementing the Gravel Augmentation Program or Restoring Riparian, Floodplain, and Side Channel Habitats Implementation of the gravel augmentation program could result in the spread of noxious and invasive weeds as a result of vegetation clearing and grubbing and an increased number of vectors. Similarly, actions to restore riparian, floodplain, and side channel habitats could also spread noxious and invasive weeds as a result of vegetation clearing and grubbing and an increased number of vectors. This impact would be potentially significant for CP4 or CP4A.

Vegetation removal and grubbing at gravel placement sites and access routes could result in increased risk of introduction and spread of noxious and invasive weeds. Riparian, floodplain, and side channel restoration projects also could result in increased risk of introduction and spread of noxious and invasive weeds.

The risk of introducing or spreading noxious weeds would vary depending on the proximity of existing noxious weed infestations, extent of ground-disturbing activities, and the amount of traffic entering a project site. Vectors that would increase as a result of project implementation include weed seed and seed parts brought in on tools, vehicles, and workers' clothing and boots. The number of weed vectors in an area would be increased by vegetation clearing and construction of temporary access routes for gravel placement and would be associated with modifying side channels and adjacent floodplain. As traffic along new and existing corridors increases, the risk for weed dispersal would increase. Seed mixtures and mulches may be used during erosion control efforts and revegetation of disturbed areas. These mixtures and mulches are potential vectors for noxious weed and invasive plant dispersal.

This impact would be potentially significant for CP4. Mitigation for this impact is proposed in Section 12.3.5, “Mitigation Measures.”

This impact would be potentially significant for CP4A. Mitigation for this impact is proposed in Section 12.3.5, “Mitigation Measures.”

Lower Sacramento River and Delta

Impact Bot-14 (CP4 and CP4A): Altered Structure and Species Composition and Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Altered Flow Regimes on the Lower Sacramento River The alteration of flow regimes associated with project implementation under CP4 or CP4A could alter the structure and species composition or cause the loss of riparian, wetland, and oak communities and habitat for special-status plant species. Vernal pool plant communities and associated special-status plant species likely would not be affected. Effects on oak communities and upland habitats for special-status plants may not all be adverse. However, adverse effects on riparian and wetland communities and associated special-status plants could be substantial on the lower Sacramento River. For riparian and wetland plant communities and associated special-status plant species on the lower Sacramento River, the impact would be significant for CP4 or CP4A, but in the Delta, the impact would be less than significant. This impact would be significant for CP4 or CP4A.

This impact would be the same as Impact Bot-14 (CP1) and would be significant for CP4. Mitigation for this impact is proposed in Section 12.3.5, “Mitigation Measures.”

This impact would be similar to Impact Bot-14 (CP1), but greater, as in Impact Bot-14 (CP2). The extent of the impact under CP4A would be greater than that under CP1 and CP4, but less than that under CP3 and CP5, which would entail more substantial alterations of flow regimes. The relative magnitude of changes to larger flows, which are most important for riparian and wetland vegetation, have been simulated for each alternative below RBPP and Hamilton City and are summarized on Figure 12-6. Therefore, for riparian and wetland plant communities and associated special-status plant species on the lower Sacramento River, the impact would be significant for CP4A, but in the Delta, the impact would be less than significant for CP4A. Mitigation for this impact is proposed in Section 12.3.5, “Mitigation Measures.”

Impact Bot-15 (CP4 and CP4A): Conflict with Approved Local or Regional Plans with Objectives of Riparian Habitat Protection or Watershed Management along the Lower Sacramento River Adopted local and regional plans address and promote the conservation of riparian vegetation and associated habitats along the lower Sacramento River. Because CP4 or CP4A would adversely affect riparian communities, this alternative could conflict with existing local and regional plans focused on preserving riparian habitats. Therefore, this impact would be potentially significant for CP4 or CP4A.

This impact would be the same as Impact Bot-15 (CP1) and would be potentially significant for CP4. Mitigation for this impact is proposed in Section 12.3.5, "Mitigation Measures."

This impact would be the same as Impact Bot-15 (CP1) and would be potentially significant for CP4A. Mitigation for this impact is proposed in Section 12.3.5, "Mitigation Measures."

Impact Bot-16 (CP4 and CP4A): Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Induced Growth along the Lower Sacramento River and in the Delta Implementation of CP4 or CP4A could increase water supplies for deliveries to water districts in the extended study area along the lower Sacramento River. This increase in water deliveries could reduce any limitation on growth that could affect sensitive plant communities and special-status plant species. However, this increase in water supply for growth that could affect these resources would be small, and in the future the effects of this growth would be analyzed and mitigated during land use planning and environmental review for specific projects. For these reasons, this impact would be less than significant for CP4 or CP4A.

This impact would be the same as Impact Bot-16 (CP1) and would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

This impact would be similar to Impact Bot-16 (CP1), but greater as in Impact Bot-16 (CP2). The extent of the impact under CP4A would be greater than that under CP1 and CP4 but less than that under CP3 and CP5, which would result in greater increases in water deliveries. This impact would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

CVP/SWP Service Areas

Impact Bot-17 (CP4 and CP4A): Altered Structure and Species Composition and Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Altered Flow Regimes in the CVP/SWP Service Areas Altered flow regimes associated with implementation of CP4 or CP4A could alter the structure and species composition or cause the loss of sensitive plant communities and habitat for special-status plant species. However, alteration of flow regimes below CVP and SWP reservoirs in the extended study area would be less than below Shasta Dam along the upper and lower Sacramento River. These alterations may not be sufficient to alter the extent of early-successional riparian and wetland communities or associated habitats for special-status plant species. Therefore, this impact would be less than significant for CP4 or CP4A.

This impact would be the same as Impact Bot-17 (CP1) and would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

This impact would be similar to Impact Bot-17 (CP1), but greater, as in Impact Bot-17 (CP2). The extent of the impact under CP4A would be greater than that under CP1 and CP4, but less than that under CP3 and CP5, which would entail more substantial alterations of flow regimes. Nonetheless, for the same reasons as Impact Bot-17 (CP1), this impact would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact Bot-18 (CP4 and CP4A): Conflict with Approved Local or Regional Plans with Objectives of Riparian Habitat Protection or Watershed Management in the CVP/SWP Service Areas Adopted local and regional plans address and promote the conservation of riparian vegetation and associated habitats along rivers below reservoirs in the CVP and SWP service areas. However, implementation of CP4 or CP4A would not cause a significant impact on riparian vegetation and habitats. Therefore, CP4 or CP4A would not conflict with existing local and regional plans focused on preserving riparian habitats. Thus, this impact would be less than significant for CP4 or CP4A.

This impact would be the same as Impact Bot-18 (CP1) and would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

This impact would be the same as Impact Bot-18 (CP1) and would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact Bot-19 (CP4 and CP4A): Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Induced Growth in the CVP/SWP Service Areas The implementation of CP4 or CP4A could increase water supplies for deliveries to water districts in the extended study area along the lower Sacramento River. This increase in water deliveries could reduce a limitation on growth that could affect sensitive plant communities and special-status plant species. However, this increase in water supplies for growth that could affect these resources would be small, and in the future the effects of this growth would be analyzed and mitigated during land use planning and environmental review for specific projects. For these reasons, this impact would be less than significant for CP4 or CP4A.

This impact would be the same as Impact Bot-19 (CP1) and would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

This impact would be similar to Impact Bot-19 (CP1), but greater, as in Impact Bot-19 (CP2) for CP4A. The extent of the impact under CP4A would be greater than that under CP1 and CP4 but less than that under CP3 and CP5, which would result in greater increases in water deliveries. This impact would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

CP5 – 18.5-Foot Dam Raise, Combination Plan

CP5 primarily focuses on increasing water supply reliability, anadromous fish survival, Shasta Lake area environmental resources, and recreation opportunities. By raising Shasta Dam 18.5 feet, in combination with spillway modifications, CP5 would increase the height of the reservoir full pool by 20.5 feet and enlarge the total storage capacity in the reservoir by 634,000 acre-feet. The existing TCD would be extended to achieve efficient use of the expanded cold-water pool. Shasta Dam operational guidelines would continue essentially unchanged, except during dry years and critical years, when 150,000 acre-feet and 75,000 acre-feet , respectively, of the increased storage capacity in Shasta Reservoir would be reserved to specifically focus on increasing M&I deliveries.

CP5 would help reduce future water shortages through increasing drought year and average year water supply reliability for agricultural and M&I deliveries. In addition, the increased depth and volume of the cold-water pool in Shasta Reservoir would contribute to improving seasonal water temperatures for anadromous fish in the upper Sacramento River.

At Shasta Lake, CP5 would also include (1) implementing environmental restoration features along the lower reaches of major tributaries, (2) constructing shoreline fish habitat, and (3) constructing either additional or improved recreation features at various locations around Shasta Lake to increase the value of the recreational experience. Formulation of specific environmental restoration features and increased recreation components is included in the Plan Formulation Appendix.

Along the upper Sacramento River, CP5 would also include implementing the same gravel augmentation program and the same riparian, floodplain, and side channel habitat restoration as described for CP4 and CP4A.

Shasta Lake and Vicinity

Impact Bot-1 (CP5): Loss of Federally or State-Listed Plant Species Habitat for Federally or State-listed plant species does not occur at Shasta Lake or in the vicinity. No species are known or expected to occur. Therefore, no impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact Bot-2 (CP5): Loss of MSCS Covered Species Implementation of the project would result in the loss of MSCS covered species as a result of ground-disturbing construction activities or inundation. Therefore, this impact would be significant.

This impact would be similar to Impact Bot-2 (CP4 and CP4A) and would be significant. Mitigation for this impact is proposed in Section 12.3.5, “Mitigation Measures.”

Impact Bot-3 (CP5): Loss of USFS Sensitive, BLM Sensitive, or CRPR Species Implementation of the project would result in the loss of USFS Sensitive, BLM

Sensitive, or CRPR species as a result of inundation, vegetation removal, or construction activities. Therefore, this impact would be potentially significant.

This impact would be similar to Impact Bot-3 (CP3) and would be potentially significant. Mitigation for this impact is proposed in Section 12.3.5, "Mitigation Measures."

Impact Bot-4 (CP5): Loss of Jurisdictional Waters Implementation of the project would result in the loss of jurisdictional waters because of flooding of the impoundment area and fill associated with the relocation of facilities and dam construction. Flooding caused by implementation of the project would result in the conversion of jurisdictional water types (e.g., wetlands and streams to lacustrine habitat). This impact would be significant.

This impact would be similar to Impact Bot-4 (CP3) and would be significant. Mitigation for this impact is proposed in Section 12.3.5, "Mitigation Measures."

Impact Bot-5 (CP5): Loss of General Vegetation Habitats Implementation of the project would result in a loss of general vegetation habitats because of inundation, vegetation removal, or construction activities. This impact would be potentially significant.

This impact would be similar to Impact Bot-5 (CP3) and would be potentially significant. Mitigation for this impact is proposed in Section 12.3.5, "Mitigation Measures."

Impact Bot-6 (CP5): Spread of Noxious and Invasive Weeds Implementation of the project could result in the spread of noxious and invasive weeds because of ground-disturbing activities during construction and an increased number of vectors (means of dispersal). This impact would be potentially significant.

Impacts resulting from the spread of noxious weeds under CP5 are anticipated to be similar to those described for CP3.

This impact would be potentially significant. Mitigation for this impact is proposed in Section 12.3.5, "Mitigation Measures."

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact Bot-7 (CP5): Altered Structure and Species Composition and Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Altered Flow Regimes Altered flow regimes associated with project implementation under CP5 could alter the structure and species composition or cause the loss of riparian, wetland, and oak communities and habitat for special-status plant species. Vernal pool plant communities and associated special-status species likely would not be affected. Effects on oak communities and upland habitats for special-status plants may not all be adverse. Adverse effects on riparian and wetland communities and associated special-status plants could be substantial; thus, this impact would be significant.

This impact would be similar to Impact Bot-7 (CP1). The extent of the impact would be greater than under CP1 because CP5 would entail more substantial alterations of flow regimes. (The relative magnitude of changes to larger flows (which are most important for riparian and wetland vegetation) simulated for each alternative below Keswick Dam and RBPP are summarized on Figure 12-6). This impact would be significant. Mitigation for this impact is proposed in Section 12.3.5, "Mitigation Measures."

Impact Bot-8 (CP5): Conflict with Approved Local or Regional Plans with Objectives of Riparian Habitat Protection or Watershed Management Numerous local and regional plans address and promote the conservation of riparian vegetation and associated habitats along the upper Sacramento River. Because CP5 would adversely affect riparian communities, this alternative could conflict with existing local and regional plans focused on preserving riparian habitats. Therefore, this impact would be potentially significant.

This impact would be the same as Impact Bot-8 (CP1) and would be potentially significant. Mitigation for this impact is proposed in Section 12.3.5, "Mitigation Measures."

Impact Bot-9 (CP5): Disturbance or Removal of Designated Critical Habitat for Special-Status Species Designated critical habitat for four vernal pool special-status plant species exists within the primary study area. However, such critical habitat is not expected to be adversely affected by CP5. This impact would be less than significant.

This impact would be similar to Impact Bot-9 (CP1). The extent of the impact would be greater than under CP1 through CP4, because CP5 would entail a greater alteration of flow regimes. However, for the same reasons as Impact Bot-9 (CP1), this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Bot-10 (CP5): Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Induced Growth Implementation of CP5 could increase water supplies for deliveries to water districts in the primary study area along the upper Sacramento River. This increase in water deliveries could reduce any limitation on growth that could affect sensitive plant communities and special-status plant species. However, this increase in water supplies for growth that could affect these resources would be small, and in the future the effects of this growth would be analyzed and mitigated during land use planning and environmental review for specific projects. For these reasons, this impact would be less than significant.

This impact would be similar to Impact Bot-10 (CP1). The extent of the impact under CP5 would be greater than that under CP1 through CP4 because it would result in a greater increase in water deliveries. However, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Bot-11 (CP5): Loss of Sensitive Natural Communities or Habitats Resulting from Implementing the Gravel Augmentation Program or Restoring Riparian, Floodplain, and Side Channel Habitats Implementation of the gravel augmentation program could result in the removal of riparian and wetland vegetation or the degradation of riparian and wetland habitats, including wetlands qualifying as waters of the United States. In addition, actions to restore riparian, floodplain, and side channel habitats at the potential downstream Sacramento River restoration sites would remove riparian vegetation, and could result in discharge of fill material into waters of the United States. This impact would be potentially significant.

This impact would be the same as Impact Bot-11 (CP4 and CP4A) and would be potentially significant. Mitigation for this impact is proposed in Section 12.3.5, “Mitigation Measures.”

Impact Bot-12 (CP5): Loss of Special-Status Plants Resulting from Implementing the Gravel Augmentation Program or Restoring Riparian, Floodplain, and Side Channel Habitats The gravel augmentation program would involve vegetation removal and gravel placement that could result in the loss of special-status plants if they are present at the gravel placement sites. Similarly, restoring riparian, floodplain, and side channel habitats would involve excavation, grading, and vegetation clearing that could result in the loss of special-status plants if they are present at the restoration sites. This impact would be potentially significant.

This impact would be the same as Impact Bot-12 (CP4 and CP4A) and would be potentially significant. Mitigation for this impact is proposed in Section 12.3.5, “Mitigation Measures.”

Impact Bot-13 (CP5): Spread of Noxious and Invasive Weeds Resulting from Implementing the Gravel Augmentation Program or Restoring Riparian, Floodplain, and Side Channel Habitats Implementation of the gravel augmentation program could result in the spread of noxious and invasive weeds as a result of vegetation clearing and grubbing and an increased number of vectors. Similarly, actions to restore riparian, floodplain, and side channel habitats could also spread noxious and invasive weeds as a result of vegetation clearing and grubbing and an increased number of vectors. This impact would be potentially significant.

This impact would be the same as Impact Bot-13 (CP4 and CP4A) and would be potentially significant. Mitigation for this impact is proposed in Section 12.3.5, “Mitigation Measures.”

Lower Sacramento River and Delta

Impact Bot-14 (CP5): Altered Structure and Species Composition and Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Altered Flow Regimes on the Lower Sacramento River Altered flow regimes associated with project implementation under CP5 could alter the structure and species composition or cause the loss of riparian, wetland, and oak communities and habitat for special-status plant species. Vernal pool plant communities and associated special-status plant species likely would not be affected. Effects on oak communities and upland habitats for special-status plants may not all be adverse. Adverse effects on riparian and wetland communities and associated special-status plants could be substantial on the lower Sacramento River. Thus, this impact would be significant.

This impact would be similar to Impact Bot-14 (CP1). The extent of the impact would be greater under CP5 than under CP1 through CP4, because CP5 would entail more substantial alterations of flow regimes. (The relative magnitude of changes to larger flows (which are most important for riparian and wetland vegetation) simulated for each alternative below RBPP and Hamilton City are summarized on Figure 12-6). This impact would be significant. Mitigation for this impact is proposed in Section 12.3.5, "Mitigation Measures."

Impact Bot-15 (CP5): Conflict with Approved Local or Regional Plans with Objectives of Riparian Habitat Protection or Watershed Management along the Lower Sacramento River Adopted local and regional plans address and promote the conservation of riparian vegetation and associated habitats along the lower Sacramento River. Because CP5 would adversely affect riparian communities, this alternative could conflict with existing local and regional plans focused on preserving riparian habitats. Therefore, this impact would be potentially significant.

This impact would be the same as Impact Bot-15 (CP1) and would be potentially significant. Mitigation for this impact is proposed in Section 12.3.5, "Mitigation Measures."

Impact Bot-16 (CP5): Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Induced Growth along the Lower Sacramento River and in the Delta Implementation of CP5 could increase water supplies for deliveries to water districts in the extended study area along the lower Sacramento River. This increase in water deliveries could reduce any limitation on growth that could affect sensitive plant communities and special-status plant species. However, this increase in water supplies for growth that could affect these resources would be small, and in the future the effects of this growth would be analyzed and mitigated during land use planning and environmental review for specific projects. For these reasons, this impact would be less than significant.

This impact would be similar to Impact Bot-16 (CP1). The extent of the impact under CP5 would be greater than that under CP1 through CP4 because it would result in a greater increase in water deliveries. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CVP/SWP Service Areas

Impact Bot-17 (CP5): Altered Structure and Species Composition and Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Altered Flow Regimes in the CVP/SWP Service Areas Altered flow regimes associated with project implementation under CP5 could alter the structure and species composition or cause the loss of sensitive plant communities and habitat for special-status plant species. However, alteration of flow regimes below CVP and SWP reservoirs in the extended study area would be less than below Shasta Dam along the upper and lower Sacramento River. These alterations may not be sufficient to alter the extent of early-successional riparian and wetland communities or associated habitats for special-status plant species. Therefore, this impact would be less than significant.

This impact would be similar to Impact Bot-17 (CP1). The extent of the impact under CP5 would be greater than that under CP1 through CP4, because it would entail more substantial alterations of flow regimes. Nonetheless, for the same reasons as Impact Bot-17 (CP2), this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Bot-18 (CP5): Conflict with Approved Local or Regional Plans with Objectives of Riparian Habitat Protection or Watershed Management in the CVP/SWP Service Areas Adopted local and regional plans address and promote the conservation of riparian vegetation and associated habitats along rivers below reservoirs in the CVP and SWP service areas. However, implementation of CP5 would not cause a significant impact on riparian vegetation and habitats. Therefore, CP5 would not conflict with existing local and regional plans focused on preserving riparian habitats. Thus, this impact would be less than significant.

This impact would be the same as Impact Bot-18 (CP1) and would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Bot-19 (CP5): Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Induced Growth in the CVP/SWP Service Areas Implementation of CP5 could increase water supplies for water districts in the CVP and SWP service areas. This increase in water deliveries could reduce a limitation on growth that could affect sensitive plant communities and special-status plant species. However, this increase in water supplies for growth that could affect these resources would be small, and in the future the effects of this growth would be analyzed and mitigated during land use planning and environmental review for specific projects. For these reasons, this impact would be less than significant.

This impact would be similar to Impact Bot-19 (CP1). The extent of the impact under CP5 would be greater than that under CP1 through CP4, because it would result in a greater increase in water deliveries. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

12.3.5 Mitigation Measures

Table 12-27 presents a summary of mitigation measures for botanical resources and wetlands.

No-Action Alternative

No mitigation measures are required for this alternative.

CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

No mitigation is needed for Impacts Bot-1 (CP1), Bot-9 (CP1) through Bot-13 (CP1), and Bot-16 (CP1) through Bot-19 (CP1). Mitigation is provided below for the remaining impacts of CP1 on botanical resources and wetlands.

Mitigation Measure Bot-2 (CP1): Acquire and Preserve Mitigation Lands; Avoid Populations; Relocate MSCS Plants; and Revegetate Affected Areas
As described in the Preliminary Environmental Commitments and Mitigation Plan Appendix, Reclamation convened an interagency working group to enhance mitigation measures presented in the DEIS. This working group had the benefit of additional information acquired during investigations of nearby private lands available for mitigation and refined analyses of potential project impacts. Using this updated information, the working group developed and refined mitigation measures for botanical and wetland resources, including Shasta snow-wreath. This mitigation measure includes the following components.

Reclamation will facilitate and implement actions necessary to acquire and/or propose land exchanges for Shasta snow-wreath populations on private land for transfer into federal ownership, including roads or other access to those lands. Alternatively, if acquisition and/or land exchange efforts are deemed insufficient, Reclamation will work with cooperating and responsible agencies to establish conservation easements at Shasta snow-wreath populations located on private land, including access to the conservation easements by State and Federal resource agencies to monitor the populations.

Reclamation will select and/or acquire test plot locations for establishment of experimental Shasta snow-wreath populations. At least four currently unoccupied sites with potential Shasta snow-wreath habitat within the STNF boundary will be selected.

Reclamation will develop a program for conservation of genetic material from Shasta snow-wreath sites subject to inundation. This program will include collection of genetic material, including seeds and scions, at all existing Shasta snow-wreath populations within the inundation area. Appropriate endowment funding for long-term maintenance and storage of at least two public botanical conservatories, one of which will be a California institution affiliated with the Center for Plant Conservation, will be provided.

Table 12-27. Summary of Mitigation Measures for Botanical Resources and Wetlands

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/CP4A	CP5
Impact Bot-1: Loss of Federally or State Listed Plant Species	LOS before Mitigation	NI	NI	NI	NI	NI	NI
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	NI	NI	NI	NI	NI	NI
Impact Bot-2: Loss of MSCS Covered Species	LOS before Mitigation	NI	S	S	S	S	S
	Mitigation Measure	None required.	Mitigation Measure Bot-2: Acquire and Preserve Mitigation Lands; Avoid Populations; Relocate MSCS Plants; and Revegetate Affected Areas.				
	LOS after Mitigation	NI	SU	SU	SU	SU	SU
Impact Bot-3: Loss of USFS Sensitive, BLM Sensitive, or CRPR Species	LOS before Mitigation	NI	PS	PS	PS	PS	PS
	Mitigation Measure	None required.	Mitigation Measure Bot-3: Acquire and Preserve Mitigation Lands; Avoid Populations; Relocate USFS Sensitive, BLM Sensitive, and CRPR Plants and Revegetate Affected Areas.				
	LOS after Mitigation	NI	SU	SU	SU	SU	SU
Impact Bot-4: Loss of Jurisdictional Waters	LOS before Mitigation	NI	S	S	S	S	S
	Mitigation Measure	None required.	Mitigation Measure Bot-4: Mitigate Loss of Jurisdictional Waters.				
	LOS after Mitigation	NI	SU	SU	SU	SU	SU
Impact Bot-5: Loss of General Vegetation Habitats	LOS before Mitigation	NI	PS	PS	PS	PS	PS
	Mitigation Measure	None required.	Mitigation Measure Bot-5: Acquire and Preserve Mitigation Lands for Loss of General Vegetation Habitats.				
	LOS after Mitigation	NI	SU	SU	SU	SU	SU

Table 12-27. Summary of Mitigation Measures for Botanical Resources and Wetlands (contd.)

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/CP4A	CP5
Impact Bot-6: Spread of Noxious and Invasive Weeds	LOS before Mitigation	NI	PS	PS	PS	PS	PS
	Mitigation Measure	None required.	Mitigation Measure Bot-6: Develop and Implement a Weed Management Plan in Conjunction with Stakeholders.				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS
Impact Bot-7: Altered Structure and Species Composition and Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Altered Flow Regimes	LOS before Mitigation	LTS	S	S	S	S	S
	Mitigation Measure	None required.	Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities.				
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
Impact Bot-8: Conflict with Approved Local or Regional Plans with Objectives of Riparian Habitat Protection or Watershed Management	LOS before Mitigation	LTS	PS	PS	PS	PS	PS
	Mitigation Measure	None required.	Mitigation Measure Bot-8: Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities.				
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
Impact Bot-9: Disturbance or Removal of Designated Critical Habitat for Special-Status Species	LOS before Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
Impact Bot-10: Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Induced Growth	LOS before Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS

Table 12-27. Summary of Mitigation Measures for Botanical Resources and Wetlands (contd.)

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/CP4A	CP5
Impact Bot-11: Loss of Sensitive Natural Communities or Habitats Resulting from Implementing the Gravel Augmentation Program or Restoring Riparian, Floodplain, and Side Channel Habitats	LOS before Mitigation	NI	NI	NI	NI	PS	PS
	Mitigation Measure	None required.	None needed; thus, none proposed.			Mitigation Measure Bot-11: Revegetate Disturbed Areas, Consult with CDFW, and Mitigate Loss of Jurisdictional Waters.	
	LOS after Mitigation	NI	NI	NI	NI	LTS	LTS
Impact Bot-12: Loss of Special-Status Plants Resulting from Implementing the Gravel Augmentation Program Restoring Riparian, Floodplain, and Side Channel Habitats	LOS before Mitigation	NI	NI	NI	NI	PS	PS
	Mitigation Measure	None required.	None needed; thus, none proposed.			Mitigation Measure Bot-12: Conduct Preconstruction Surveys for Special-Status Plants and Avoid Special-Status Plant Populations during Construction.	
	LOS after Mitigation	NI	NI	NI	NI	LTS	LTS
Impact Bot-13: Spread of Noxious and Invasive Weeds Resulting from Implementing the Gravel Augmentation Program Restoring Riparian, Floodplain, and Side Channel Habitats	LOS before Mitigation	NI	NI	NI	NI	PS	PS
	Mitigation Measure	None required.	None needed; thus, none proposed.			Mitigation Measure Bot-13: Implement Weed Management Measures and Revegetation.	
	LOS after Mitigation	NI	NI	NI	NI	LTS	LTS

Table 12-27. Summary of Mitigation Measures for Botanical Resources and Wetlands (contd.)

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/CP4A	CP5
Impact Bot-14: Altered Structure and Species Composition and Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Altered Flow Regimes on the Lower Sacramento River	LOS before Mitigation	LTS	S	S	S	S	S
	Mitigation Measure	None required.	Mitigation Measure Bot-14: Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities.				
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
Impact Bot-15: Conflict with Approved Local or Regional Plans with Objectives of Riparian Habitat Protection or Watershed Management along the Lower Sacramento River	LOS before Mitigation	PS	PS	PS	PS	PS	PS
	Mitigation Measure	None required.	Mitigation Measure Bot-15: Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities.				
	LOS after Mitigation	PS	LTS	LTS	LTS	LTS	LTS
Impact Bot-16: Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Induced Growth along the Lower Sacramento River and in the Delta	LOS before Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed				
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
Impact Bot-17: Altered Structure and Species Composition and Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Altered Flow Regimes in the CVP/SWP Service Areas	LOS before Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS

Table 12-27. Summary of Mitigation Measures for Botanical Resources and Wetlands (contd.)

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/CP4A	CP5
Impact Bot-18: Conflict with Approved Local or Regional Plans with Objectives of Riparian Habitat Protection or Watershed Management in the CVP/SWP Service Areas	LOS before Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.					
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
Impact Bot-19: Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Induced Growth in CVP/SWP Service Areas	LOS before Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.					
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS

Key:
CP = Comprehensive Plan
CVP = Central Valley Project
LOS = level of significance
LTS = less than significant
NA = not applicable
NI = no impact
PS = potentially significant
S = significant
SU = significant and unavoidable
SWP = State Water Project

Reclamation will investigate the feasibility of protecting Shasta snow-wreath populations to be inundated with dikes/berms. Two existing Shasta snow-wreath sites will be chosen for their genetic diversity and and/or extent. Reclamation will then investigate the feasibility of building dike or berm structures designed to eliminate the flooding that would otherwise occur at the new inundation level at these Shasta snow-wreath sites.

Reclamation will develop an active management program for existing Shasta snow-wreath populations. The program, which will be led by Reclamation and include appropriate stakeholders, will provide active management of known Shasta snow-wreath populations outside of the project area on USFS lands to enhance and protect these existing populations. Management activities will include measures to increase fire suppression capacity, use of prescribed fire under rigorous experimental conditions, fencing, integrated weeds management including weed inventory, control (mechanical, chemical, cultural, and biological), abatement, monitoring, and public education. This mitigation measure applies to known and any newly established experimental populations.

Additional studies to determine the biology of Shasta snow-wreath will be conducted by Reclamation. Studies will be undertaken to understand the pollination biology of Shasta snow-wreath and the genetic compatibility of different genotypes and to understand the conditions under which sexual reproduction occurs in this species. Seed germination and scion rooting techniques will be explored to find reliable means of producing material for establishment of experimental populations.

Reclamation will establish an outreach communication program to local land owners and determine if additional Shasta snow-wreath populations occur on private land. Following development, Reclamation will implement the communications program, including applicable subsequent outreach and monitoring.

Reclamation will develop a Shasta Snow-wreath Conservation Agreement. This Conservation Agreement will serve as the overall management document for Shasta snow-wreath and include all responsible State and Federal resource management agencies and appropriate private landowners. At a minimum, the Conservation Agreement will include the following sections:

- Introduction
- Geographic area and entities included in the agreement
- Authority, purpose, objective, and management goal(s) of the Conservation Agreement
- Description, status, distribution, ecology, and population biology of the species

- Known and potential threats to the species
- Current threats of destruction, modification, or curtailment of its habitat or range
- Issues related to overutilization for commercial, recreational, scientific, or educational purposes
- Disease or predation
- Efficacy of existing regulatory mechanisms
- Other natural or manmade factors affecting the species' continued existence
- Conservation or management actions that will be implemented
- Funding of conservation or management actions
- Duration of agreement
- Signatures
- References

The STNF has established monitoring transects in eight Shasta snow-wreath populations, with three years of data for seven populations and two years of data for the eighth population. Reclamation will continue the monitoring efforts at the established populations and expand the effort to additional populations, based on criteria developed by Conservation Agreement participants.

The following mitigation measures will reduce impacts on other MSCS plants, if applicable:

- When feasible in relocation areas, avoid or minimize actions that can result in harm or mortality to individuals or to the viability of populations.
- When feasible, Reclamation will relocate populations of MSCS plants that will be directly affected to suitable habitat within undisturbed portions of the Shasta Lake and vicinity portion of the primary study area.
- When feasible, Reclamation will use seed banking and other *ex situ* (off site) conservation methods for MSCS populations that will be directly affected.

- When feasible, Reclamation will restore/enhance populations of other MSCS plants in the project vicinity.

- A mitigation and monitoring plan will be developed to monitor success of MSCS plant populations that have been relocated or revegetated. The plan will identify suitable sites for mitigation, species to be planted, and numbers and sizes of plantings. It will describe planting techniques, prescribe methods to remove existing noxious weeds, and establish reasonable performance standards and contingency measures. Furthermore, it will establish conservation easements as appropriate. The vegetation restoration plan will be developed in consultation with coordinating and responsible agencies (e.g., USACE, USFWS, and USFS).

- Where appropriate, MSCS covered plant species will be used for revegetation.

Implementation of this mitigation measure would reduce impacts on MSCS plant species; however, because successful relocation, transplanting, and artificial propagation of Shasta snow-wreath are unproven, impacts would remain significant and unavoidable.

Mitigation Measure Bot-3 (CP1): Acquire and Preserve Mitigation Lands; Avoid Populations; Relocate USFS Sensitive, BLM Sensitive, and CRPR Plants and Revegetate Affected Areas As described in the Preliminary Environmental Commitments and Mitigation Plan Appendix, Reclamation convened an interagency working group to enhance mitigation measures presented in the DEIS. This working group had the benefit of additional information from recent investigations of nearby private lands available for mitigation and refined analyses of potential project impacts. Using this updated information, the working group developed and refined mitigation measures for botanical and wetland resources, including include land acquisition, habitat management and enhancement, and other measures.

Mitigation measure Bot-3 consists of a program to acquire nearby private lands with similar habitat attributes and species composition as those impacted by the SLWRI project. Reclamation has identified several willing private landowners and specific parcels for purchase in the project area vicinity. Preliminary investigations of these lands have shown they contain similar and/or additional habitats and special-status species as those impacted by SLWRI. Special-status plant species known to occur on the lands subject to these preliminary investigations include Shasta huckleberry, Shasta arnica, Shasta limestone monkeyflower, Canyon Creek stonecrop, Howell’s lewisa, and Shasta eupatory. Additionally, the interagency working group identified other private parcels with similar biological resources in the vicinity of the project area, some of which have owners willing to discuss purchase agreements.

As discussed during the interagency working group meetings, mitigation measure Bot-3 will begin with a 3:1 minimum replacement ratio of acquired lands to impacted lands. The interagency working group also agreed that additional considerations will be made for other replacement ratios (more or less) depending on habitat quality at a particular site. Emphasis will be placed on lands containing high value habitats (e.g., riparian, wetland, limestone, blue oak woodlands) and/or special-status species populations.

This mitigation measure includes the following components intended to reduce impacts on USFS sensitive, BLM sensitive, and CRPR plants:

- When feasible in relocation areas, avoid or minimize actions that can result in harm or mortality to individuals or to the viability of populations.

- When feasible, Reclamation will relocate populations of USFS sensitive, BLM sensitive, and CRPR plants that will be directly affected to suitable habitat within undisturbed portions of the Shasta Lake and vicinity portion of the primary study area.

- When feasible, Reclamation will use seed banking and other *ex situ* (off site) conservation methods for USFS sensitive, BLM sensitive, and CRPR plant populations that will be directly affected.

- When feasible, Reclamation will restore/enhance populations of other USFS sensitive, BLM sensitive, and CRPR plants in the project vicinity.

- Reclamation will develop a mitigation and monitoring plan to monitor success of USFS sensitive, BLM sensitive, and CRPR plant populations that have been relocated or revegetated. The plan will identify suitable sites for mitigation, species to be planted, and numbers and sizes of plantings. It will describe planting techniques, prescribe methods to remove existing noxious weeds, and establish reasonable performance standards and contingency measures. Furthermore, it will establish conservation easements as appropriate. The vegetation restoration plan will be developed in consultation with cooperating and responsible agencies (e.g., USACE, USFWS, USFS).

- To the extent feasible, USFS sensitive, BLM sensitive, and CRPR plant species will be used for revegetation.

Implementation of this mitigation measure would reduce impacts on USFS sensitive, BLM sensitive, and CRPR plant species; however, because successful relocation and transplantation of these species are unproven, impacts would remain potentially significant and unavoidable.

Mitigation Measure Bot-4 (CP1): Mitigate Loss of Jurisdictional Waters Reclamation will prepare a conceptual wetland mitigation plan following current USACE guidance and requirements. The mitigation plan will incorporate wetland habitats within lands acquired under Bot-3 as appropriate, and may include additional mitigation lands. The wetland mitigation plan will also include measures for wetland habitat creation, restoration, and/or enhancement.

Under CP1, Bot-4 will mitigate for the loss of approximately 14 acres of wetlands and 19 acres of other waters of the U.S. in the inundation area, and approximately 2 acres of wetlands and 2 acres of other waters of the U.S. in the relocation areas. Collectively Bot-4 (CP1) will mitigate for the loss of approximately 16 acres of wetlands and approximately 21 acres of other waters of the U.S.

Until the details of this mitigation measure are developed through the ongoing planning process, Impact Bot-4 (CP1) would remain significant and unavoidable.

Mitigation Measure Bot-5 (CP1): Acquire, Preserve, and Restore Mitigation Lands for Loss of General Vegetation Habitats As described in Bot-3, mitigation lands will be acquired to mitigate for the loss of vegetation habitat. Additionally, opportunities for restoration and enhancement of habitat will be explored and defined. Mitigation measure Bot-5 will begin with a 3:1 minimum replacement ratio of acquired lands to impacted lands. This ratio will be applied to each specific habitat type. Additional considerations will be made for other replacement ratios (more or less) depending on habitat quality at a particular site. Emphasis will be placed on lands containing high-value habitats (e.g., riparian, wetland, limestone, blue oak woodlands) and/or special-status species populations.

Under CP1, Bot-5 will mitigate for the loss of 1,227 acres of habitats in the inundation area and 698 acres in the relocation areas by acquiring a minimum of 5,775 acres of mitigation lands containing comparable habitats.

Until the details of this mitigation measure are developed, Impact Bot-5 (CP1) would remain significant and unavoidable.

Mitigation Measure Bot-6 (CP1): Develop and Implement a Weed Management Plan in Conjunction with Stakeholders Reclamation will develop and implement a weed management plan in conjunction with stakeholders to avoid or minimize the potential for project-related impacts from noxious and invasive plants. This plan will incorporate a combination of inventory, adaptive measures for treatment of existing populations, and measures for controlling spread. The plan will have long-term consideration and be designed as an ongoing program. At a minimum, the plan will include:

- Identification of key established weed populations for removal/treatment.
- Measures to treat source populations, prevent introduction of new infestations during project construction, and ongoing maintenance.
- Provide a mechanism for monitoring and addressing weed populations as the new shoreline develops over time.
- Include objective statements which are achievable and can be readily implemented (e.g., to protect potentially impacted sensitive species, to minimize project impacts, to avoid and control weed spread that affects rare and otherwise desirable species, recreation, fuels/fire implications).
- Consideration for construction-related species, which may be distinctly different from species likely to invade new inundation areas.

Environmental commitments outlined in Chapter 2, “Alternatives,” include measures to use native species for revegetation and erosion control in construction areas, including establishment of local source populations for seed/propagule collection; include standard equipment cleaning provisions in all construction contracts; and use only weed-free road fill, gravel, mulches, and erosion control devices.

Implementation of these measures would reduce Impact Bot-6 (CP1) to a less-than-significant level.

Mitigation Measure Bot-7 (CP1): Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities Reclamation will implement a riverine ecosystem mitigation and adaptive management plan to mitigate to the extent feasible the identified effects of an altered Sacramento River flow regime on existing riparian and wetland communities, and associated instream, riparian, and wetland habitat values for aquatic and terrestrial special-status species along the Sacramento River from Shasta Dam to Colusa (River Mile 144). The plan is consistent with and will support implementation of the Senate Bill 1086 program, and will be implemented in coordination with USFWS, NMFS, CDFW, and the Sacramento River Conservation Area Forum. The plan will be implemented before or during project construction. The plan is limited to the Sacramento River from Shasta Dam to Colusa (River Mile 144). The plan mitigates to the existing conditions as of 2010 which are considered the baseline conditions.

The goals of the plan, which also serve as performance standards, are to have no net reduction in the average amount of any of the following caused by the project along the Sacramento River from Shasta Dam to Colusa:

- Channel migration in selected areas of natural vegetation dominated by native species
- Overbank inundation of natural vegetation dominated by native species in selected areas
- Regeneration of early-successional riparian vegetation (e.g., cottonwood regeneration) in selected areas

The riverine ecosystem mitigation plan includes a menu of potentially feasible elements:

- Modeling or monitoring at representative locations to quantify direct and indirect impacts resulting from adaptive management of project implementation. A method of quantifying impacts will be used that ensures repeatability. This would include at least one of the following approaches:
  - Conducting aerial surveys to evaluate changes in riparian habitat communities
  - Development and monitoring of up to 15 riparian habitat transects along the Sacramento River at potentially sensitive locations (e.g., downstream from the confluence of tributaries, downstream from diversion structures)

  Monitoring would be conducted for an initial 10-year period, after which the need for continued monitoring would be re-evaluated.
- An evaluation of modifications to the procedures for operating Shasta Dam (e.g., ramping rates) to accomplish any of the following:
  - Reduce or eliminate adverse impacts on ecologically important bankfull and overbank flows (as feasible within existing flood reduction constraints)
  - Reduce or eliminate adverse impacts (e.g., reduction) on meander migration rates
  - Facilitate establishment of cottonwoods and early-successional vegetation at intervals sufficient to sustain cottonwoods and early-successional riparian vegetation along the Sacramento River riparian corridor and floodplain (e.g., at 5- to 15-year intervals)

  - Avoid any increase in flood risk from implementing this mitigation measure. Feasible modifications to operational procedures are those not in conflict with applicable laws, agreements, and regulations, or with the purpose of the project.

- A specific combination of mitigation actions will be implemented to attain the plan's goals. Mitigation actions consist of modifications to dam operation procedures and/or funding of appropriate restoration actions that have been developed by Reclamation, other Federal agencies, State or local governments, or private nonprofits and received applicable Federal and State permits. Appropriate restoration actions include the following:

  - Enhance connectivity of river side channels (e.g., by modifying the elevation of secondary channels, remnant oxbows, or meander scars)

  - Expand the river meander zone at selected locations (e.g., by assisting in funding projects that meet this objective)

  - Increase floodplain connectivity (e.g., by assisting in funding projects that meet this objective)

  - Control and remove nonnative, invasive plant species from riparian areas to shift dominance to native species

  - Create riparian and wetland communities (e.g., through plantings)

  - Increase shaded riverine aquatic habitat (e.g., through plantings)

The following will be considered in implementation of the riverine ecosystem mitigation plan:

- The adaptive management process will evaluate the performance of the restoration actions towards meeting the performance standards and goals.

- The location of restoration actions will be on preserved sites and with funding for management in perpetuity. (Preserved sites will include sites previously preserved by other entities.) A specific restoration plan will be developed for each restoration location and coordinated with resource agencies and local stakeholders.

- Mechanisms by which Reclamation will fund implementation will be determined after project approval for implementation.

At a minimum, mitigation that will be implemented under this plan will include the following:

- Feasible modifications to dam operation procedures identified as reducing adverse impacts on meander migration or ecologically important bankfull and overbank flows, or as facilitating cottonwood establishment, and

- Either of the following elements:

  – Provide actions or funding to increase meander migration, side-channel connectivity, or floodplain connectivity along the Sacramento River, and creation (or conversion of nonnative-dominated to native-dominated) of riparian or wetland communities

or

  – Provide mitigation that has been determined by USFWS, NMFS, and CDFW to be of comparable or greater value and is included in the terms and conditions of permits for impacts on species listed as threatened or endangered by the State or Federal governments

Implementation of this mitigation measure would mitigate the impact of altered flow regimes on instream, riparian, and wetland communities, and thus would reduce Impact Bot-7 (CP1) to a less-than-significant level.

Mitigation Measure Bot-8 (CP1): Implement Mitigation Measure Bot-7 (CP1): Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Reduce Conflicts with Approved Local or Regional Plans with Objectives of Riparian Habitat Protection or Watershed Management Reclamation will implement Mitigation Measure Bot-7 (CP1) as described above.

As described under Mitigation Measure Bot-7 (CP1), implementing a riverine ecosystem mitigation plan would reduce conflicts with approved local and regional plans that address and promote the conservation of riparian vegetation communities along the upper Sacramento River in the primary study area. Consequently, implementation of the previous mitigation measure would reduce Impact Bot-8 (CP1) to a less-than-significant level.

Mitigation Measure Bot-14 (CP1): Implement Mitigation Measure Bot-7 (CP1): Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities This measure is identical to Mitigation Measure Bot-7 (CP1) as described above. Reclamation will implement a riverine ecosystem mitigation plan.

Implementation of this mitigation measure would reduce Impact Bot-14 (CP1) to a less-than-significant level.

Mitigation Measure Bot-15 (CP1): Implement Mitigation Measure Bot-7 (CP1): Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Reduce Conflicts with Approved Local or Regional Plans with Objectives of Riparian Habitat Protection or Watershed Management Reclamation will implement Mitigation Measure Bot-7 (CP1) as described above.

As described under Mitigation Measure Bot-7 (CP1), implementing a riverine ecosystem mitigation plan would reduce conflicts with approved local and regional plans that address and promote the conservation of riparian vegetation communities along the lower Sacramento River in the extended study area. Consequently, implementing the previous mitigation measure would reduce Impact Bot-15 (CP1) to a less-than-significant level.

CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

No mitigation is needed for Impacts Bot-1 (CP2), Bot-9 (CP2) through Bot-13 (CP2), and Bot-16 (CP2) through Bot-19 (CP2). Mitigation is provided below for the remaining impacts of CP2 on botanical resources and wetlands.

Mitigation Measure Bot-2 (CP2): Acquire and Preserve Mitigation Lands; Avoid Populations; Relocate MSCS Plants; and Revegetate Affected Areas This mitigation measure is identical to Mitigation Measure Bot-2 (CP1). Implementation of this mitigation measure would reduce impacts on Shasta snow-wreath; however, because many of the proposed mitigation measures relocation of this species are unproven, the impact would remain significant and unavoidable.

Mitigation Measure Bot-3 (CP2): Acquire and Preserve Mitigation Lands; Avoid Populations; Relocate USFS Sensitive, BLM Sensitive and CRPR Plants and Revegetate Affected Areas This mitigation measure is identical to Mitigation Measure Bot-3 (CP1). Implementation of this mitigation measure would reduce impacts on USFS sensitive, BLM sensitive and CRPR plant species; however, because relocation of these species is unproven, the impact would remain significant and unavoidable.

Mitigation Measure Bot-4 (CP2): Mitigate Loss of Jurisdictional Waters This mitigation measure is identical to Mitigation Measure Bot-4 (CP1).

Under CP2, Bot-4 will mitigate for the loss of approximately 19 acres of wetlands and 26 acres of other waters of the U.S. in the inundation area, and approximately 2 acres of wetlands and 2 acres of Other Waters of the U.S. in the relocation areas. Collectively Bot-4 (CP2) will mitigate for the loss of approximately 21 acres of wetlands and approximately 28 acres of other waters of the U.S.

Until the details of this mitigation measure are developed, Impact Bot-4 (CP2) would remain significant and unavoidable.

Mitigation Measure Bot-5 (CP2): Acquire and Preserve Mitigation Lands for Loss of General Vegetation Habitats This mitigation measure is identical to Mitigation Measure Bot-3 (CP1).

Under CP2, Bot-5 will mitigate for the loss of 1,725 acres of habitats in the inundation area and 698 acres in the relocation areas by acquiring a minimum of 7,269 acres of mitigation lands containing comparable habitats.

Until the details of this mitigation measure are developed, Impact Bot-5 (CP2) would remain significant and unavoidable.

Mitigation Measure Bot-6 (CP2): Develop and Implement a Weed Management Plan in Conjunction with Stakeholders This mitigation measure is identical to Mitigation Measure Bot-6 (CP1). Implementation of this mitigation measure would reduce Impact Bot-6 (CP2) to a less-than-significant level.

Mitigation Measure Bot-7 (CP2): Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities This mitigation measure is identical to Mitigation Measure Bot-7 (CP1), except that mitigation in the riverine ecosystem mitigation plan will include either of the following elements:

- Increased meander migration, side-channel connectivity, or floodplain connectivity along the Sacramento River, and creation (or conversion from nonnative-dominated to native-dominated) of riparian or wetland communities

or

- Mitigation that has been determined by USFWS, NMFS, and CDFW to be of comparable or greater value and is included in the terms and conditions of permits for impacts on species listed as threatened or endangered by the State or Federal government

Implementation of this mitigation measure would reduce Impact Bot-7 (CP2) to a less-than-significant level.

Mitigation Measure Bot-8 (CP2): Implement Mitigation Measure Bot-7 (CP2): Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Reduce Conflicts with Approved Local or Regional

Plans with Objectives of Riparian Habitat Protection or Watershed Management Reclamation will implement Mitigation Measure Bot-7 (CP2) as described above.

Implementing this riverine ecosystem mitigation plan would reduce conflicts with approved local and regional plans that address and promote the conservation of riparian vegetation communities along the upper Sacramento River in the primary study area. Implementation of this mitigation measure would reduce Impact Bot-8 (CP2) to a less-than-significant level.

Mitigation Measure Bot-14 (CP2): Implement Mitigation Measure Bot-7 (CP2): Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities This mitigation measure is identical to Mitigation Measure Bot-7 (CP2). Reclamation will implement a riverine ecosystem mitigation plan.

Implementation of this mitigation measure would reduce Impact Bot-14 (CP2) to a less-than-significant level.

Mitigation Measure Bot-15 (CP2): Implement Mitigation Measure Bot-7 (CP2): Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Reduce Conflicts with Approved Local or Regional Plans with Objectives of Riparian Habitat Protection or Watershed Management Reclamation will implement Mitigation Measure Bot-7 (CP2) as described above.

Implementing this riverine ecosystem mitigation plan would reduce conflicts with approved local and regional plans that address and promote the conservation of riparian vegetation communities along the lower Sacramento River in the extended study area. Implementation of this mitigation measure would reduce Impact Bot-15 (CP2) to a less-than-significant level.

CP3 – 18.5-Foot Dam Raise, Agricultural Water Supply Reliability and Anadromous Fish Survival

No mitigation is needed for Impacts Bot-1 (CP3), Bot-9 (CP3) through Bot-13 (CP3), and Bot-16 (CP3) through Bot-19 (CP3). Mitigation is provided below for the remaining impacts of CP3 on botanical resources and wetlands.

Mitigation Measure Bot-2 (CP3): Acquire and Preserve Mitigation Lands; Avoid Populations; Relocate MSCS Plants; and Revegetate Affected Areas This mitigation measure is identical to Mitigation Measure Bot-2 (CP1). Implementation of this mitigation measure would reduce impacts on Shasta snow-wreath; however, because many of the proposed mitigation measures for relocation of this species are unproven, the impact would remain significant and unavoidable.

Mitigation Measure Bot-3 (CP3): Acquire and Preserve Mitigation Lands; Avoid Populations; Relocate USFS Sensitive, BLM Sensitive and CRPR Plants and Revegetate Affected Areas This mitigation measure is identical to Mitigation Measure Bot-3 (CP1). Implementation of this mitigation measure would reduce impacts on USFS sensitive, BLM sensitive and CRPR plant species; however, because relocation of these species is unproven, the impact would remain significant and unavoidable.

Mitigation Measure Bot-4 (CP3): Mitigate Loss of Jurisdictional Waters This mitigation measure is identical to Mitigation Measure Bot-4 (CP1).

Under CP3, Bot-4 will mitigate for the loss of approximately 29 acres of wetlands and 48 acres of other waters of the U.S. in the inundation area, and approximately 2 acres of wetlands and 2 acres of Other Waters of the U.S. in the relocation areas. Collectively Bot-4 (CP3) will mitigate for the loss of approximately 31 acres of wetlands and approximately 50 acres of Other Waters of the U.S.

Until the details of this mitigation measure are developed, Impact Bot-4 (CP3) would remain significant and unavoidable.

Mitigation Measure Bot-5 (CP3): Acquire and Preserve Mitigation Lands for Loss of General Vegetation Habitats This mitigation measure is identical to Mitigation Measure Bot-3 (CP1).

Under CP3, Bot-5 will mitigate for the loss of 2,492 acres of habitats in the inundation area and 698 acres in the relocation areas by acquiring a minimum 9,570 acres of mitigation lands containing comparable habitats.

Until the details of this mitigation measure are developed, Impact Bot-5 (CP3) would remain significant and unavoidable.

Mitigation Measure Bot-6 (CP3): Develop and Implement a Weed Management Plan in Conjunction with Stakeholders This mitigation measure is identical to Mitigation Measure Bot-6 (CP1). Implementation of this mitigation measure would reduce Impact Bot-6 (CP3) to a less-than-significant level.

Mitigation Measure Bot-7 (CP3): Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities This mitigation measure is identical to Mitigation Measure Bot-7 (CP1), except that mitigation in the riverine ecosystem mitigation plan will include either of the following elements:

- Increased meander migration, side-channel connectivity, or floodplain connectivity along the Sacramento River, and creation (or conversion from nonnative-dominated to native-dominated) of riparian or wetland communities

or

- Mitigation that has been determined by USFWS, NMFS, and CDFW to be of comparable or greater value and is included in the terms and conditions of permits for impacts on species listed as threatened or endangered by the State or Federal government.

Implementation of this mitigation measure would reduce Impact Bot-7 (CP3) to a less-than-significant level.

Mitigation Measure Bot-8 (CP3): Implement Mitigation Measure Bot-7 (CP3): Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Reduce Conflicts with Approved Local or Regional Plans with Objectives of Riparian Habitat Protection or Watershed Management Reclamation will implement Mitigation Measure Bot-7 (CP3) as described above.

The implementation of this riverine ecosystem mitigation plan would reduce conflicts with approved local and regional plans that address and promote the conservation of riparian vegetation communities along the upper Sacramento River in the primary study area. Implementation of this mitigation measure would reduce Impact Bot-8 (CP3) to a less-than-significant level.

Mitigation Measure Bot-14 (CP3): Implement Mitigation Measure Bot-7 (CP3): Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities This mitigation measure is identical to Mitigation Measure Bot-7 (CP3). Reclamation will implement a riverine ecosystem mitigation plan.

Implementation of this mitigation measure would reduce Impact Bot-14 (CP3) to a less-than-significant level.

Mitigation Measure Bot-15 (CP3): Implement Mitigation Measure Bot-7 (CP3): Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Reduce Conflicts with Approved Local or Regional Plans with Objectives of Riparian Habitat Protection or Watershed Management Reclamation will implement Mitigation Measure Bot-7 (CP3) as described above.

The implementation of this riverine ecosystem mitigation plan would reduce conflicts with approved local and regional plans that address and promote the conservation of riparian vegetation communities along the lower Sacramento River in the extended study area. Implementation of this mitigation measure would reduce Impact Bot-15 (CP3) to a less-than-significant level.

CP4 and CP4A – 18.5-Foot Dam Raise, Anadromous Fish Focus with Water Supply Reliability

No mitigation is needed for Impacts Bot-1 (CP4 and CP4A), Bot-9 (CP4 and CP4A), Bot-10 (CP4 and CP4A), and Bot-16 (CP4 and CP4A) through Bot-19 (CP4 and CP4A). Mitigation is provided below for the remaining impacts of CP4 or CP4A on botanical resources and wetlands.

Mitigation Measure Bot-2 (CP4 and CP4A): Acquire and Preserve Mitigation Lands; Avoid Populations; Relocate MSCS Plants; and Revegetate Affected Areas This mitigation measure is identical to Mitigation Measure Bot-2 (CP1). Implementation of this mitigation measure would reduce impacts on Shasta snow-wreath; however, because many of the proposed mitigation measures for relocation of this species are unproven, the impact would remain significant and unavoidable.

Mitigation Measure Bot-3 (CP4 and CP4A): Acquire and Preserve Mitigation Lands; Avoid Populations; Relocate USFS Sensitive, BLM Sensitive and CRPR Plants and Revegetate Affected Areas This mitigation measure is identical to Mitigation Measure Bot-3 (CP1).

Implementation of this mitigation measure would reduce impacts on USFS sensitive, BLM sensitive, and CRPR plant species; however, because relocation of these species is unproven, the impact would remain significant and unavoidable.

Mitigation Measure Bot-4 (CP4 and CP4A): Mitigate Loss of Jurisdictional Waters This mitigation measure is identical to Mitigation Measure Bot-4 (CP1).

Until the details of this mitigation measure are developed, Impact Bot-4 (CP4 and CP4A) would remain significant and unavoidable.

Mitigation Measure Bot-5 (CP4 and CP4A): Acquire and Preserve Mitigation Lands for Loss of General Vegetation Habitats This mitigation measure is identical to Mitigation Measure Bot-3 (CP1).

Until the details of this mitigation measure are developed, Impact Bot-5 (CP4 and CP4A) would remain significant and unavoidable.

Mitigation Measure Bot-6 (CP4 and CP4A): Develop and Implement a Weed Management Plan in Conjunction with Stakeholders This mitigation measure is identical to Mitigation Measure Bot-6 (CP1).

Implementation of this mitigation measure would reduce Impact Bot-6 (CP4 and CP4A) to a less-than-significant level.

Mitigation Measure Bot-7 (CP4 and CP4A): Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and

Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities This mitigation measure is identical to Mitigation Measure Bot-7 (CP1).

Implementation of this mitigation measure would reduce Impact Bot-7 (CP4 and CP4A) to a less-than-significant level.

Mitigation Measure Bot-8 (CP4 and CP4A): Implement Mitigation Measure Bot-7 (CP1): Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Reduce Conflicts with Approved Local or Regional Plans with Objectives of Riparian Habitat Protection or Watershed Management This mitigation measure is identical to Mitigation Measure Bot-7 (CP1).

Implementation of this mitigation measure would reduce Impact Bot-8 (CP4 and CP4A) to a less-than-significant level.

Mitigation Measure Bot-11 (CP4 and CP4A): Revegetate Disturbed Areas, Consult with CDFW, and Mitigate Loss of Jurisdictional Waters Reclamation will implement the following measures to reduce and compensate for loss of sensitive natural communities:

- Before removing any vegetation at the augmentation sites and access areas, a survey will be conducted to map and classify the natural communities present in these areas, including wetland communities.
- Augmentation access will be designed to avoid disturbing wetland plant communities to the extent feasible. Removal of mature riparian vegetation and other sensitive vegetation will be minimized to the extent possible while still allowing access to gravel augmentation sites.
- CDFW will be consulted with to determine if a Section 1602 streambed alteration agreement will be required for the gravel augmentation activities affecting the bed and bank of the Sacramento River and side channels.
- Staging and gravel and equipment storage will be confined to developed or disturbed areas to the extent feasible.
- A revegetation plan will be prepared to restore native vegetation in all areas cleared to implement the gravel augmentation program immediately following completion of the gravel augmentation activities at each augmentation site. The revegetation plan will include performance standards and success criteria to ensure that mitigation habitat would be successfully maintained and result in no net loss of sensitive natural communities, including riparian vegetation.

- All conditions of the streambed alteration agreement will be implemented to the satisfaction of CDFW, subject to limitations on its authority set forth in Fish and Game Code Section 1600 et seq.

In addition, Reclamation will implement the following measures to reduce and compensate for potential loss of sensitive natural communities from the riparian, floodplain, and side channel restoration actions:

- A survey will be conducted before removing any vegetation at the augmentation sites and access areas to map and classify the natural communities present in restoration and potential construction areas at restoration sites.

- CDFW will be consulted with to determine if a Section 1602 streambed alteration agreement will be required for the restoration and construction activities at each restoration site affecting the bed and bank of the Sacramento River and side channel.

- Relocated and/or rehabilitated facilities (e.g., power poles) will be designed to avoid disturbing sensitive plant communities to the extent feasible.

- A 100-foot no disturbance buffer will be established around sensitive plant communities that are to be avoided during construction. Removal of mature riparian vegetation and other sensitive vegetation will be minimized to the extent possible.

- Staging, equipment storage, and construction access will be designed to avoid disturbing vegetation to the extent feasible.

- Native riparian and other sensitive vegetation, if any, removed from restoration sites will be replaced on a no-net-loss basis. Riparian vegetation will be replaced through planting and establishment of comparable native riparian vegetation on-site. Other sensitive plant communities may be replaced through restoration of comparable native vegetation at other sites if necessary.

- Planting mix, composition, and density will be determined by a more detailed site analysis, but could include native cottonwood, willow, box elder, valley oak, western sycamore, elderberry, and a variety of understory brush species. Temporary irrigation will be provided on an as-needed basis, where feasible.

- All conditions of the streambed alteration agreement will be implemented to the satisfaction of CDFW, subject to limitations on its authority set forth in Fish and Game Code Section 1600 et seq.

Reclamation will prepare and implement a wetland mitigation plan following current USACE guidance and requirements. The wetland mitigation plan will include measures for wetland habitat creation, restoration, and/or enhancement.

Implementation of this mitigation measure would reduce Impact Bot-11 (CP4 and CP4A) to a less-than-significant level.

Mitigation Measure Bot-12 (CP4 and CP4A): Conduct Preconstruction Surveys for Special-Status Plants and Avoid Special-Status Plant Populations during Construction Reclamation will implement the following measures to avoid impacts on special-status plants resulting from the gravel augmentation program:

- Botanists will be hired to conduct protocol-level special-status plant surveys before commencing any construction activities that could disturb vegetation.
- All special-status plants identified within 250 feet of the proposed augmentation sites will be mapped and identified for avoidance. Access routes and gravel placement will be designed to avoid impacts on special-status plants.
- Fencing will be installed a minimum of 100 feet from special-status plants, and no project activity will be permitted within the area occupied by special-status plants or the 100-foot buffer area around these plants.
- Insecticides, herbicides, fertilizers, or other chemicals that might harm special-status plants will not be used within 100 feet of the plants. Roadways and disturbed areas within 100 feet of special-status plants will be watered at least twice a day and as needed to minimize dust emissions.

In addition, Reclamation will implement the following measures to avoid impacts on special-status plants resulting from the riparian, floodplain, and side channel restoration actions:

- Qualified botanists will be hired to conduct protocol-level special-status plant surveys before commencing any construction activities that could disturb vegetation.
- All special-status plants identified within 250 feet of the proposed augmentation sites will be mapped and avoided to the extent feasible. Protective fencing will be installed around special-status plant locations and a 100-foot buffer zone during construction activities.

- Insecticides, herbicides, fertilizers, or other chemicals that might harm special-status plants will not be used within 100 feet of special-status plants. Roadways and disturbed areas within 100 feet of special-status plants will be watered at least twice a day and as needed to minimize dust emissions.

Implementation of this mitigation measure would reduce Impact Bot-12 (CP4 and CP4A) to a less-than-significant level.

Mitigation Measure Bot-13 (CP4 and CP4A): Implement Weed Management Measures and Revegetation Reclamation will implement the following measures to reduce the risk of introducing and spreading noxious weeds or invasive plant species during gravel augmentation and riparian, floodplain, and side channel restoration:

- Before conducting gravel augmentation activities, invasive plant and noxious weed infestations will be identified and mapped within the augmentation sites, including vegetation clearing sites.

- Noxious weeds will be removed at the onset of construction and disposed of properly. If noxious weeds are not removed at the onset of construction, they will be fenced and avoided during construction.

- Any clothing, footwear, and equipment used during construction will be ensured free of soil, seeds, vegetative matter or other debris or potential seed-bearing material before entering the project sites or before moving from infested sites to uninfested sites.

- Mitigation Measure Bot-11 (CP4 and CP4A) will be implemented to restore native vegetation in all areas disturbed by gravel placement and construction of access routes immediately following completion of the gravel augmentation activities at each augmentation site.

- Only weed-free gravel, fill soil, mulch, seed mixes, and straw materials will be used during construction; best management practices will be implemented; and postconstruction revegetation will be conducted. Certified weed-free material will be used if available.

Implementation of this mitigation measure would reduce Impact Bot-13 (CP4 and CP4A) to a less-than-significant level.

Mitigation Measure Bot-14 (CP4 and CP4A): Implement Mitigation Measure Bot-7 (CP1): Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities This mitigation measure is identical to Mitigation Measure Bot-7 (CP1).

Implementation of this mitigation measure would reduce Impact Bot-14 (CP4 and CP4A) to a less-than-significant level.

Mitigation Measure Bot-15 (CP4 and CP4A): Implement Mitigation Measure Bot-7 (CP1): Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Reduce Conflicts with Approved Local or Regional Plans with Objectives of Riparian Habitat Protection or Watershed Management This mitigation measure is identical to Mitigation Measure Bot-7 (CP1). Implementation of this mitigation measure would reduce Impact Bot-15 (CP4 and CP4A) to a less-than-significant level.

CP5 – 18.5-Foot Dam Raise, Combination Plan

No mitigation is needed for Impacts Bot-1 (CP5), Bot-9 (CP5), Bot-10 (CP5), and Bot-16 (CP5) through Bot-19 (CP5). Mitigation is provided below for the remaining impacts of CP5 on botanical resources and wetlands.

Mitigation Measure Bot-2 (CP5): Acquire and Preserve Mitigation Lands; Avoid Populations; Relocate MSCS Plants; and Revegetate Affected Areas This mitigation measure is identical to Mitigation Measure Bot-2 (CP1). Implementation of this mitigation measure would reduce impacts on Shasta snow-wreath; however, because many of the proposed mitigation measures for relocation of this species are unproven, the impact would remain significant and unavoidable.

Mitigation Measure Bot-3 (CP5): Acquire and Preserve Mitigation Lands; Avoid Populations; Relocate USFS Sensitive, BLM Sensitive and CRPR Plants and Revegetate Affected Areas This mitigation measure is identical to Mitigation Measure Bot-3 (CP1). Implementation of this mitigation measure would reduce impacts on USFS sensitive, BLM sensitive, and CRPR plant species; however, because relocation of these species is unproven, the impact would remain significant and unavoidable.

Mitigation Measure Bot-4 (CP5): Mitigate Loss of Jurisdictional Waters This mitigation measure is identical to Mitigation Measure Bot-4 (CP1).

Until the details of this mitigation measure are developed, Impact Bot-4 (CP5) is considered significant and unavoidable.

Mitigation Measure Bot-5 (CP5): Acquire and Preserve Mitigation Lands for Loss of General Vegetation Habitats This mitigation measure is identical to Mitigation Measure Bot-3 (CP1).

Until the details of this mitigation measure are developed, Impact Bot-5 (CP5) would remain significant and unavoidable.

Mitigation Measure Bot-6 (CP5): Develop and Implement a Weed Management Plan in Conjunction with Stakeholders This mitigation measure is identical to Mitigation Measure Bot-6 (CP1). Implementation of this mitigation measure would reduce Impact Bot-6 (CP5) to a less-than-significant level.

Mitigation Measure Bot-7 (CP5): Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities This mitigation measure is identical to Mitigation Measure Bot-7 (CP3). Implementation of this mitigation measure would reduce Impact Bot-7 (CP5) to a less-than-significant level.

Mitigation Measure Bot-8 (CP5): Implement Mitigation Measure Bot-7 (CP3): Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Reduce Conflicts with Approved Local or Regional Plans with Objectives of Riparian Habitat Protection or Watershed Management This mitigation measure is identical to Mitigation Measure Bot-7 (CP3). Implementation of this mitigation measure would reduce Impact Bot-8 (CP5) to a less-than-significant level.

Mitigation Measure Bot-11 (CP5): Revegetate Disturbed Areas, Consult with CDFW, and Mitigate Loss of Jurisdictional Waters This mitigation measure is identical to Mitigation Measure Bot-11 (CP4 and CP4A). Implementation of this mitigation measure would reduce Impact Bot-11 (CP5) to a less-than-significant level.

Mitigation Measure Bot-12 (CP5): Conduct Preconstruction Surveys for Special-Status Plants and Avoid Special-Status Plant Populations during Construction This mitigation measure is identical to Mitigation Measure Bot-12 (CP4 and CP4A). Implementation of this mitigation measure would reduce Impact Bot-12 (CP5) to a less-than-significant level.

Mitigation Measure Bot-13 (CP5): Implement Weed Management Measures and Revegetation This mitigation measure is identical to Mitigation Measure Bot-13 (CP4 and CP4A). Implementation of this mitigation measure would reduce Impact Bot-13 (CP5) to a less-than-significant level.

Mitigation Measure Bot-14 (CP5): Implement Mitigation Measure Bot-7 (CP3): Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities This mitigation measure is identical to Mitigation Measure Bot-7 (CP3). Implementation of this mitigation measure would reduce Impact Bot-14 (CP5) to a less-than-significant level.

Mitigation Measure Bot-15 (CP5): Implement Mitigation Measure Bot-7 (CP3): Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Reduce Conflicts with Approved Local or Regional Plans with Objectives of Riparian Habitat Protection or Watershed

Management This mitigation measure is identical to Mitigation Measure Bot-7 (CP3). Implementation of this mitigation measure would reduce Impact Bot-15 (CP5) to a less-than-significant level.

12.3.6 Cumulative Effects

Chapter 3, “Considerations for Describing the Affected Environment and Environmental Consequences,” discusses overall cumulative impacts methodology related to the action alternatives, including the relationship to the CALFED Bay-Delta Program Programmatic EIS/EIR cumulative impacts analysis, qualitative and quantitative assessment, past and future actions in the study area, and significance criteria. Table 3-1, “Present and Reasonably Foreseeable Future Actions Included in the Analysis of Cumulative Impacts, by Resource Area,” in Chapter 3, lists the present and reasonably foreseeable future projects considered quantitatively and qualitatively within the cumulative impacts analysis. This cumulative impacts analysis accounts for potential project impacts combined with the impacts of existing facilities, conditions, land uses, and reasonably foreseeable actions expected to occur in the study area on a qualitative and quantitative level.

The action alternatives would not combine with any of the quantitatively assessed projects listed in Table 3-1 to have a cumulatively considerable impact on botanical resources in the primary study area. Impacts on botanical resources in the extended study area from these projects would not combine with the impacts from any of the action alternatives as the geographic scope of the impacts do not overlap.

The following analysis relates to the cumulative impacts of the qualitatively assessed projects listed in Table 3-1 when considered with the impacts of the action alternatives. Projects listed in Table 3-1 that could contribute to a cumulative impact on botanical resources in the primary and extended study area include, but are not limited to, Sacramento River Basin Salmonid Rearing Habitat Improvements, Bay-Delta Conservation Plan, Sacramento River Conservation Area Forum Program, Butte Regional Conservation Plan, Fremont Landing Conservation Bank, Antlers Bridge Replacement, Moody Flats Quarry, and Mountain Gate at Shasta Mixed-Use Plan.

A large number of past actions have occurred in the primary and extended study areas. These past actions have substantially degraded botanical resources and wetlands within the study areas. This degradation is indicated by the number of species that have been listed as threatened or endangered under the CESA and Federal ESA, and by the large portion of all native plant species that are now assigned a CRPR, listed by CDFW and CNPS. Consequently, there is an existing significant cumulative impact on botanical resources.

Past actions have caused these effects by converting habitat to developed or agricultural land uses, altering biotic interactions or physical processes, and damaging or causing mortality from human activities (e.g., vegetation removal during road, levee, or utility maintenance).

Most botanical resources and wetlands in the study areas have been adversely affected by most of the mechanisms described above (i.e., conversion of habitat to developed or agricultural land uses, the spread of invasive species, alteration of physical processes, and human disturbance). Overall, these botanical resources and wetlands have been substantially degraded by past actions, and past actions are continuing to affect them. In particular, the geographic range and abundance (and thus the effects) of many nonnative, invasive plant species that were introduced into the study areas in the past are still rapidly increasing.

The construction of Shasta Dam and the subsequent flooding of the area now known as Shasta Lake affected botanical and wildlife resources endemic to the region. For example, based on existing population locations, Shasta snow-wreath populations may have connected at the confluence of the Pit, Squaw, McCloud, and Sacramento rivers before inundation. The creation of Shasta Lake fragmented the habitat and populations of this species. As a result, these populations are more vulnerable to extirpation.

The effects of climate change on operations at Shasta Lake could potentially affect botanical resources both at the lake and downstream. As described in the Climate Change Modeling Appendix, climate change could result in higher reservoir releases in the future because of an increase in winter and early-spring inflow into the lake from high-intensity storm events. The change in reservoir releases could be necessary to manage for flood events resulting from these potentially larger storms. The potential increase in releases from the reservoir could lead to long-term changes in flooding frequency and acreages and distribution of vegetation.

Shasta Lake and Vicinity

As described in Section 12.3, without mitigation, CP1 through CP5 could cause potentially significant effects on botanical and wetland resources in the primary and extended study areas. These effects could be caused by project construction activities; increased elevations of the water surface of Shasta Lake; and alteration of the flow regime of the Sacramento River and associated geomorphic processes, and thus of riparian vegetation. Although causing similar effects, CP1 through CP5 differ in the magnitude of their effects. At Shasta Lake and its vicinity, these potential adverse effects would be similar for all alternatives, but differ with the height of the dam raise: the effects of CP2 and CP4A would be greater than CP1, but less than CP3 through CP5 (which would be identical). Along the upper Sacramento River and in the extended study area, potential adverse effects would be the result of altered flow regimes and would differ with both the height of the dam raise and operation of the dam: the effects of CP2 and CP4A would be greater than CP1 and CP4 (which would be identical), but less than CP3 and CP5 (which also would have identical effects).

At Shasta Lake and vicinity, CP1 through CP5 would cause the loss of MSCS Covered Species, USFS sensitive, BLM sensitive, or CRPR Species, Jurisdictional Waters, and general habitats, and could cause the spread of noxious and invasive weeds. The mitigation measures described in Section 12.3.6 would reduce impacts on botanical and wetland resources. However, the adverse effects of CP1 through CP5 caused by construction activities and inundation would not be eliminated, with the exception of noxious and invasive weed impacts (Impact Bot-6). Because the overall effect of past actions on botanical resources and wetlands has been cumulatively significant, and the likely additional effects of reasonably foreseeable future actions on these at Shasta Lake and in its vicinity, the adverse effects under CP1 through CP5 (except Impact Bot-6) would potentially be cumulatively considerable and these effects would be potentially cumulatively significant. Because mitigation measures to control the spread of weeds would effectively address the project's impact from that mechanism, however, CP1 through CP5 would not make a cumulatively considerable incremental contribution to an overall significant cumulative impact on plants and wetlands from noxious and invasive weeds.

Upper Sacramento River and Extended Study Area

Along the Sacramento River and other rivers downstream from CVP and SWP reservoirs, substantial past alterations to geomorphic processes, vegetation, and associated habitats have resulted in an overall significant and substantial effect on these resources. For example, as a result of past actions, wetland and riparian vegetation occupies less than 10 percent of its historical extent in the Central Valley (DWR 2012). Therefore, additional adverse effects that are considered to have cumulatively considerable incremental contributions would increase the existing significant cumulative impact. This adverse effect would be the result of the continued consequences of past actions (e.g., construction of Shasta Dam and introduction of nonnative species), and of present and foreseeable water resource and levee actions whose adverse effects may not be fully mitigated.

Most adverse effects that are the continued consequences of past actions have been considered in the development of existing local and regional plans. Consequently, with respect to local and regional plans, an overall significant cumulative effect does not already exist. However, the adverse effects of all present and reasonably foreseeable water resources and levee actions are not likely to be avoided or fully mitigated. The unmitigated impact of these actions could be sufficiently considerable to result in a significant cumulative impact overall.

Habitat loss along the upper Sacramento River and in the extended study area already has resulted in an overall effect on sensitive communities and special-status plants that is significant and substantial. (This is the primary reason that a large number of plant species along the upper Sacramento River and in the extended study area have been listed as threatened or endangered by the State or Federal governments, or have been assigned a CRPR by CDFW and CNPS.)

CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability As described in Chapter 2, “Alternatives,” without mitigation, by altering the flow regime and associated geomorphic processes on the Sacramento River, CP1 could affect sensitive plant communities and special-status species (Impact Bot-7 (CP1) and Bot-14 (CP1)) and could potentially affect regional or local plans with objectives of riparian habitat protection or watershed management (Impact Bot-8 (CP1) and Bot-15 (CP1)). These effects could occur on the upper Sacramento River and portions of the lower Sacramento River. Because substantial past alterations to geomorphic processes, vegetation, and associated habitats along the Sacramento River have resulted in an overall significant cumulative effect on these resources, additional incremental adverse effects would likely be cumulatively considerable. However, with the implementation of Mitigation Measure Bot-7 (CP1), adverse effects from CP1 on botanical resources and wetlands along the Sacramento River would be fully mitigated. Thus, CP1 would not result in a cumulatively considerable incremental impact on these resources, and the potential to affect regional or local plans would also be eliminated. Therefore, the impacts of CP1 would not make a cumulatively considerable incremental contribution to a significant cumulative impact.

By altering the flow regimes below CVP and SWP reservoirs in the extended study area, CP1 could possibly cause similar effects on these rivers as along the Sacramento River. (These effects were identified as Impacts Bot-17 (CP1) and Bot-18 (CP1).) However, the alteration of these flow regimes would be less extensive than along the Sacramento River. Even without mitigation, the effects of CP1 on these rivers might not be sufficient to alter the extent or species composition of sensitive communities or to alter the habitats of special-status plant species. In addition, Mitigation Measure Aqua-15 (CP1), “Maintain Flows in the Feather River, American River, and Trinity River Consistent with Existing Regulatory and Operational Requirements and Agreements,” would reduce these effects to a level that is unlikely to alter the extent or species composition of sensitive communities or to alter the extent or quality of habitat for special-status plant species. Therefore, the impacts of CP1 would not make a cumulatively considerable incremental contribution to a significant cumulative impact.

By altering flow regimes on the upper Sacramento River, CP1 also could affect designated critical habitat for special-status species of vernal pool habitats (Impact Bot-9 (CP1)). However, vernal pool plant communities and associated special-status species likely would not be affected by any of the alternatives. Therefore, the project would not make a cumulatively considerable incremental contribution to a significant cumulative impact on critical habitat for special-status species of vernal pool habitats.

Along the upper Sacramento River and in the extended study area, CP1 could induce growth that results in the loss of sensitive plant communities and special-status plant species (Impacts Bot-10 (CP1), Bot-16 (CP1), and Bot-19

(CP1)). Habitat loss has resulted in an overall significant cumulative effect on sensitive communities and special-status plants that is substantial. (It is the primary reason that a large number of plant species along the upper Sacramento River and in the extended study area have been listed as threatened or endangered by the State or Federal governments, or have been assigned a CRPR by CDFW and CNPS.) CP1 could induce growth-related effects because it would increase water supplies for deliveries to water districts, and this could reduce a limitation on growth. For example, most CVP water supports agricultural purposes, and agricultural acreages are not expected to increase substantially over time.

However, some increment of the CVP water could be used for municipal and industrial contractors, such as Contra Costa Water District or Santa Clara Valley Water District, as would SWP water. In this case, some growth-related effects could occur from development and have an incremental effect on botanical resources and wetlands. Present and foreseeable future projects are also likely to add to this habitat loss. Although the future effects of any growth-related effects induced by CP1 would be analyzed and mitigated during land use planning and environmental review for site-specific development projects, it is unlikely that all effects would be avoided or fully mitigated. Therefore, CP1 would make a small incremental, but cumulatively considerable, contribution to an existing significant cumulative impact. This would be a cumulatively significant and unavoidable impact.

As stated previously, effects of climate change on operations at Shasta Lake could include a higher frequency of high flow events, potentially resulting in changes to downstream vegetation. Potentially significant effects on vegetation and special-status species that would occur with implementation of CP1 could contribute to potentially significant impacts of climate change on habitat acreages and distribution. Although the mitigation measures listed above would be implemented to reduce project-related impacts of CP1, CP1 would still make a cumulatively considerable incremental contribution to a significant cumulative impact on botanical resources and wetlands. This would be a cumulatively significant and unavoidable impact.

CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability The cumulative effects of CP2 would be similar to those of CP1, but greater in magnitude (because CP2 would entail more substantial alterations of flow regimes). Although greater in magnitude than the effects of CP1, the effects of CP2 on sensitive plant communities and special-status species along the upper Sacramento River and in the extended study area (Impacts Bot-7 (CP2), Bot-14 (CP2), and Bot-17 (CP2)), and potential effects on regional or local plans with objectives of riparian habitat protection or watershed management (Impacts Bot-8 (CP2), Bot-15 (CP2), and Bot-18 (CP2)) would not make a cumulatively considerable incremental contribution to a significant cumulative impact, for the same reasons given for CP1.

Similarly, although greater in magnitude than the effects of CP1, the impact of CP2 on designated critical habitat for special-status species of vernal pool habitats (Impact Bot-9 (CP2)) would not be a cumulatively considerable incremental contribution to a significant cumulative impact for the same reasons given for CP1.

Also similar to CP1, along the upper Sacramento River and in the extended study area, CP2 could cause growth-related effects that result in the loss of sensitive plant communities and special-status plant species (Impacts Bot-10 (CP2), Bot-16 (CP2), and Bot-19 (CP2)). However, the potential for CP2 to cause growth-related effects would be greater than for CP1. For the same reasons given for CP1, CP2 would make a small incremental, but cumulatively considerable, contribution to an existing significant cumulative impact. This would be a cumulatively significant and unavoidable impact.

As stated previously, effects of climate change on operations at Shasta Lake could include a higher frequency of high flow events, potentially resulting in changes to downstream vegetation. Potentially significant effects on vegetation and special-status species that would occur with implementation of CP2 could contribute to potentially significant impacts of climate change on habitat acreages and distribution. Although mitigation measures listed above would be implemented to reduce project-related impacts of CP2, CP2 would still make a cumulatively considerable incremental contribution to a significant cumulative impact on botanical resources and wetlands. This would be a cumulatively significant and unavoidable impact.

CP3 – 18.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply
The cumulative effects of CP3 would be similar to those of CP1 and CP2, but greater in magnitude. Although greater in magnitude than the effects of CP1 or CP2 (because CP3 would entail more substantial alterations of flow regimes), the effects of CP3 on sensitive plant communities and special-status species along the upper Sacramento River and in the extended study area (Impacts Bot-7 (CP3), Bot-14 (CP3), and Bot-17 (CP3)), and potential effects on regional or local plans with objectives of riparian habitat protection or watershed management (Impacts Bot-8 (CP3), Bot-15 (CP3), and Bot-18 (CP3)) would not make a cumulatively considerable incremental contribution to a significant cumulative impact, for the same reasons given for CP1.

Similarly, although greater in magnitude than the effects of CP1 or CP2, the effects of CP3 on designated critical habitat for special-status species of vernal pool habitats (Impact Bot-9 (CP3)) would not make a cumulatively considerable incremental contribution to a significant cumulative impact, for the same reasons given for CP1.

Also similar to CP1 and CP2, along the upper Sacramento River and in the extended study area, CP3 could cause growth-related effects that result in the loss of sensitive plant communities and special-status plant species (Impacts

Bot-10 (CP3), Bot-16 (CP3), and Bot-19 (CP3)). However, because CP3 would not reserve any storage capacity to specifically focus on increasing M&I deliveries, the potential for CP3 to cause growth-related effects would be less than for CP1 or CP2. For the same reasons given for CP1, CP3 would make a small incremental, but cumulatively considerable, contribution to an existing significant cumulative impact. This would be a cumulatively significant and unavoidable impact.

As stated previously, effects of climate change on operations at Shasta Lake could include a higher frequency of high flow events, potentially resulting in changes to downstream vegetation. Potentially significant effects on vegetation and special-status species that would occur with implementation of CP3 could contribute to potentially significant impacts of climate change on habitat acreages and distribution. Although mitigation measures listed above would be implemented to reduce project-related impacts of CP3, CP3 would still make a cumulatively considerable incremental contribution to a significant cumulative impact on botanical resources and wetlands. This would be a cumulatively significant and unavoidable impact.

CP4 and CP4A – 18.5-Foot Dam Raise, Anadromous Fish Focus with Water Supply Reliability The cumulative effects of CP4 would be the same as CP1, and the effects of CP4A would be the same as CP2, except that CP4 and CP4A would also result in effects from the gravel augmentation program, and riparian, floodplain, and side channel restoration in the primary study area.

However, the gravel augmentation program, and riparian, floodplain, and side channel restoration actions would not make a cumulatively considerable incremental contribution to a significant cumulative impact on botanical resources and wetlands. These additional actions would not cause growth-related effects or effects on vernal pool habitats, but could affect sensitive plant communities, special-status species, and invasive plants. To sensitive communities, the overall, long-term effect of the gravel augmentation program and riparian, floodplain, and side channel restoration actions would be beneficial, and Mitigation Measure Bot-11 (CP4 and CP4A), Revegetate Disturbed Areas; Consult with CDFW, would substantially reduce the effects of any localized, short-term vegetation removal during their implementation. Without additional mitigation, however, these actions could adversely affect special-status species and facilitate the spread of invasive plants. Implementing mitigation measures Bot-12 (CP4 and CP4A), Conduct Preconstruction Surveys for Special-Status Plants and Avoid Special-Status Plant Populations during Construction, and Bot-13 (CP4 and CP4A), Implement Weed Management Measures and Revegetation, would avoid effects on special-status plants and effectively prevent facilitation of the spread of invasive plants.

As stated previously, effects of climate change on operations at Shasta Lake could include a higher frequency of high-flow events, potentially resulting in changes to downstream vegetation. Potentially significant effects on vegetation and special-status species that would occur with implementation of CP4 or CP4A could contribute to potentially significant impacts of climate change on habitat acreages and distribution. However, the gravel augmentation program and the riparian, floodplain, and side channel restoration actions would not make a cumulatively considerable incremental contribution to a significant cumulative impact on botanical resources and wetlands. The overall, long-term effect of the gravel augmentation program and riparian, floodplain, and side channel restoration actions would be beneficial. Further, the mitigation measures described immediately above would be implemented and avoid effects on special-status plants and effectively prevent facilitation of the spread of invasive plants, including during climate change and an expected increase in high-flow events.

Consequently, the gravel augmentation and riparian, floodplain, and side channel restoration actions would not make a cumulatively considerable incremental contribution to a potentially significant cumulative impact on botanical resources and wetlands.

CP5 – 18.5-Foot Dam Raise, Combination Plan The cumulative effects of CP5 would be similar to those of CP1, CP2, CP3, CP4, and CP4A, but greater in magnitude. Although greater in magnitude than the effects of CP1 through CP4 (because CP5 would entail more substantial alterations of flow regimes), the effects of CP5 on sensitive plant communities and special-status species along the upper Sacramento River and in the extended study area (Impacts Bot-7 (CP5), Bot-14 (CP5), and Bot-17 (CP5)), and potential effects on regional or local plans with objectives of riparian habitat protection or watershed management (Impacts Bot-8 (CP5), Bot-15 (CP5), and Bot-18 (CP5)) would not make a cumulatively considerable incremental contribution to a significant cumulative impact, for the same reasons given for CP1.

Similarly, although greater in magnitude than the effects of CP1 through CP4, the effects of CP5 on designated critical habitat for special-status species of vernal pool habitats (Impact Bot-9 (CP5)) would not make a cumulatively considerable incremental contribution to a significant cumulative impact, for the same reasons given for CP1.

CP5 includes the same gravel augmentation program and riparian, floodplain, and side channel restoration actions included in CP4 and CP4A. For the same reasons given for CP4 and CP4A, the effects of the gravel augmentation program and the restoration actions on sensitive communities, special-status species, and spread of invasive plants would not make a cumulatively considerable incremental contribution to a significant cumulative impact.

Similar to CP1 through CP4, along the upper Sacramento River and in the extended study area, CP5 could cause growth-related effects that result in the loss of sensitive plant communities and special-status plant species (Impacts Bot-10 (CP5), Bot-16 (CP5), and Bot-19 (CP5)). However, the potential for

CP5 to cause growth-related effects would be greater than for CP1 through CP4, because it would result in a greater increase in average annual water deliveries. For the same reasons given for CP1, CP5 would make a small incremental, but cumulatively considerable, contribution to an existing significant cumulative impact. This would be a cumulatively significant and unavoidable impact.

As stated previously, effects of climate change on operations at Shasta Lake could include a higher frequency of high flow events, potentially resulting in changes to downstream vegetation. Potentially significant effects on vegetation and special-status species that would occur with implementation of CP5 could contribute to potentially significant impacts of climate change on habitat acreages and distribution. Although mitigation measures listed above would be implemented to reduce project-related impacts of CP5, CP5 would still make a cumulatively considerable incremental contribution to a significant cumulative impact on botanical resources and wetlands.

Chapter 13
Wildlife Resources

13.1 Affected Environment

This section describes the affected environment related to wildlife resources, including special-status species, for the dam and reservoir modifications proposed under SLWRI action alternatives. For a more in-depth description, see the *Wildlife Resources Technical Report.*

Shasta Dam and Shasta Lake are located on the upper Sacramento River in Northern California. Shasta Dam is located approximately 9 miles northwest of Redding, and the dam and entire reservoir are located in Shasta County. Elevations in the Shasta Lake vicinity portion of the primary study area range between approximately 1,070 and 1,200 feet, and the terrain is moderate to steep.

The wildlife resources setting for the Shasta Lake and vicinity portion of the primary study area consists of the impoundment area (five arms and the main body of Shasta Lake) and the relocation areas (Figure 13-1). The Shasta Lake and vicinity portion of the primary study area is composed of Shasta Dam and Shasta Lake and the lower reaches of the tributaries draining into Shasta Lake.

Reclamation established project boundaries for focused surveys in the area that would be subject to inundation under various enlargement scenarios. The lower boundary corresponds to the current full-pool elevation defined by Reclamation (1,070-foot mean sea level (msl) contour line). The upper boundary was established using the 1,090-foot msl contour line around the entire lake. This area is hereafter referred to as the “impoundment area” (Figure 13-1).

To examine the physical and biological resources along riverine habitats that would be subject to inundation if Shasta Dam were enlarged, reaches of 11 streams and rivers that are tributary to Shasta Lake were also incorporated into the Shasta Lake and vicinity portion of the primary study area. These streams were selected by Reclamation in conjunction with USFS as an initial sampling of streams representative of riverine and riparian habitats.

Areas subject to physical disturbance as an indirect result of the proposed project (i.e., areas proposed as relocation sites for roadways, bridges, utilities, and campgrounds that would be inundated subsequent to the enlargement of Shasta Dam as well as proposed dike locations) were incorporated into the

Shasta Lake and vicinity portion of the primary study area. These locations are hereafter referred to as “relocation areas” (Figure 13-1).

In addition to the areas subject to inundation and/or relocation, Reclamation has identified six locations considered for river restoration. These six locations are referred to as the potential Sacramento River downstream habitat restoration areas (Figure 13-2).

For the purposes of this investigation, approximate acreages for habitat types are reported by arm of the lake. For a relocation area that falls between two arms, the area is included with the arm that has the most acreage of the vegetation type or water of the United States.

Descriptions of biological resources were derived primarily from the following sources:

- SLWRI Mission Statement Milestone Report (Reclamation 2003)
- SLWRI Initial Alternatives Information Report (Reclamation 2004)
- Chapter 3, “Biological Environment,” in the Draft SLWRI Plan Formulation Report (Reclamation 2007)
- USFWS Endangered Species Lists
- California Natural Diversity Database (CNDDB)
- Numerous technical studies of botanical, wetland, and wildlife resources conducted by Reclamation in the Shasta Lake and vicinity portion of the primary study area since 2002.

Several attachments to the *Wildlife Resources Technical Report* provide detailed lists and descriptions of special-status wildlife species present in the primary and extended study areas:

- Attachment 1, Special-Status Wildlife Species Potentially Occurring in the Shasta Lake and Vicinity Portion of the Primary Study Area
- Attachment 2, Species Accounts for Special-Status Wildlife in the Shasta Lake and Vicinity Portion of the Primary Study Area
- Attachment 3, Breeding Bird Surveys 2007-2013
- Attachment 4, Species Accounts for Special-Status Wildlife in the Primary Study Area Downstream from Shasta Dam
- Attachment 5, Federal Lists of Special-Status Wildlife Species in the Vicinity of the Primary Study Area

- Attachment 6, Special-Status Wildlife Species with Potential to Occur in the Primary and Extended Study Areas by Area
- Attachment 7, List of All Sensitive Wildlife Species in the Extended Study Area Reported to the CNDDB
- Attachment 8, Forest Carnivore Survey Report
- Attachment 9, Shasta Salamander Survey Report
- Attachment 10, Terrestrial Mollusk Survey Report
- Attachment 11, California Red-legged Frog Habitat Assessment Reports, Shasta Lake and Vicinity Portion of the Primary Study Area
- Attachment 12, Biological Characterizations, SLWRI Potential Sacramento River Downstream Habitat Restoration Areas: Henderson Open Space
- Attachment 13, Biological Characterizations, SLWRI Potential Sacramento River Downstream Habitat Restoration Areas: Tobiasson Island
- Attachment 14, Biological Characterizations, SLWRI Potential Sacramento River Downstream Habitat Restoration Areas: Shea Island Complex
- Attachment 15, Biological Characterizations, SLWRI Potential Sacramento River Downstream Habitat Restoration Areas: Kapusta Island
- Attachment 16, Biological Characterizations, SLWRI Potential Sacramento River Downstream Habitat Restoration Areas: Anderson River Park
- Attachment 17, Biological Characterizations, SLWRI Potential Sacramento River Downstream Habitat Restoration Areas: Reading Island
- Attachment 18, California Red-legged Frog Habitat Assessment, SLWRI Potential Sacramento River Downstream Habitat Restoration Areas: Henderson Open Space
- Attachment 19, California Red-legged Frog Habitat Assessment, SLWRI Potential Sacramento River Downstream Habitat Restoration Areas: Tobiasson Island

- Attachment 20, California Red-legged Frog Habitat Assessment, SLWRI Potential Sacramento River Downstream Habitat Restoration Areas: Shea Island Complex

- Attachment 21, California Red-legged Frog Habitat Assessment, SLWRI Potential Sacramento River Downstream Habitat Restoration Areas: Kapusta Island

- Attachment 22, California Red-legged Frog Habitat Assessment, SLWRI Potential Sacramento River Downstream Habitat Restoration Areas: Anderson River Park

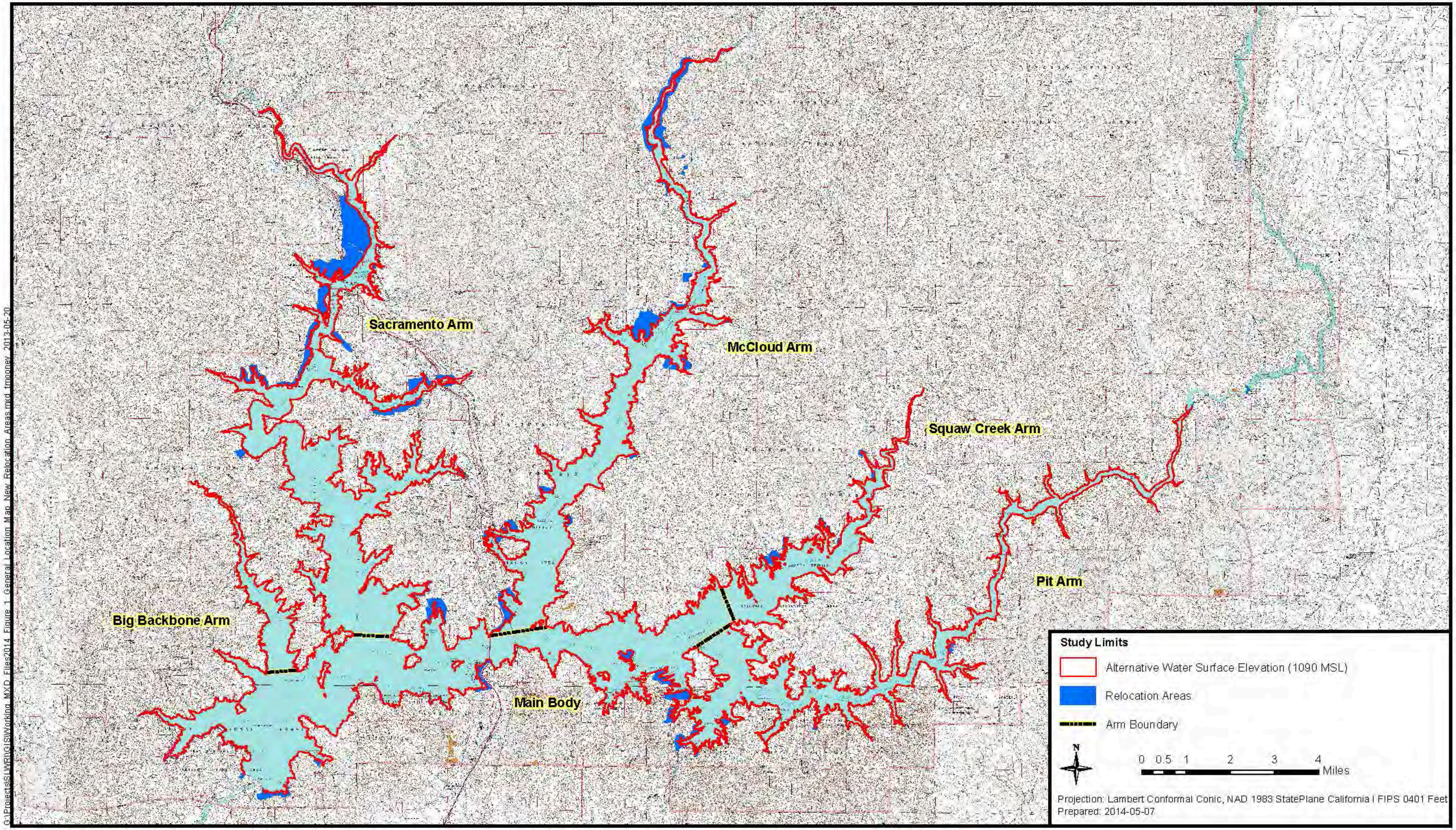
- Attachment 23, California Red-legged Frog Habitat Assessment, SLWRI Potential Sacramento River Downstream Habitat Restoration Areas: Reading Island

13.1.1 Wildlife

Shasta Lake and Vicinity

Wildlife resources described in this chapter result from the wealth and diversity of climatic and vegetative associations in and adjacent to the Shasta Lake and vicinity portion of the primary study area. Influences from the southeastern Klamath Mountains, Coast Ranges, the southern Cascade Range, the northern Sierra Nevada, the Great Basin, and the Central Valley provide for a unique mix of biota. Much of this region, especially in the Central Valley, has been modified by past and present land uses.

Wildlife Habitats The Shasta Lake and vicinity portion of the primary study area is characterized by a variety of habitats typical of mixed woodlands and low-elevation forests found in the southeastern Klamath Mountains. These habitats were mapped and classified using the *Guide to Wildlife Habitats of California* (Mayer and Laudenslayer 1988). Habitats present in the Shasta Lake and vicinity portion of the primary study area are summarized in Tables 13-1 and 13-2, and depicted in Figures 13-3a through 13-3f. General habitat descriptions, including typically occurring wildlife species, are described below. Plant taxonomy follows Baldwin et al. (2012).



Key: MSL = feet above mean sea level

Figure 13-1. Study Limits

This page left blank intentionally.

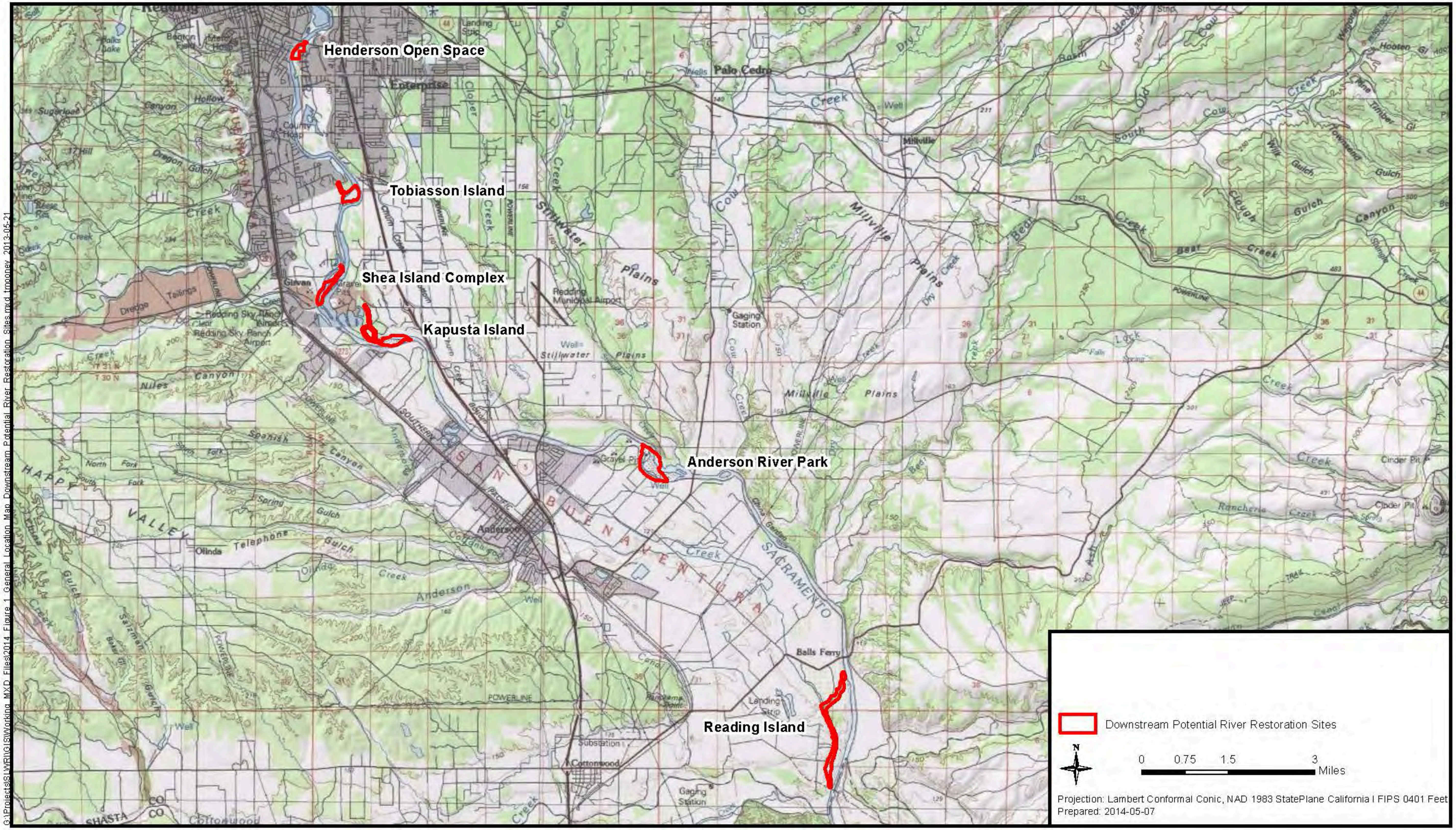


Figure 13-2. General Location Map Downstream Potential River Restoration Areas

This page left blank intentionally.

Table 13-1. Summary of Wildlife Habitats in the Impoundment Area

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Annual grassland	0.44	0.00	3.10	0.70	0.00	0.38	4.61
Barren	2.30	0.00	10.60	3.56	0.00	1.35	17.81
Blue oak–foothill pine	10.36	0.00	0.00	0.00	4.29	32.33	46.98
Blue oak woodland	0.00	0.00	0.00	0.00	0.00	4.18	4.18
Closed-cone pine–cypress	32.68	0.00	12.95	20.89	44.72	70.52	181.77
Douglas-fir	0.00	0.00	0.00	0.36	0.00	0.00	0.36
Klamath Mixed Conifer	0.00	0.00	0.00	0.00	0.00	10.96	10.96
Mixed chaparral	29.19	13.64	161.04	15.14	10.35	12.99	242.36
Montane hardwood	73.49	38.76	171.01	70.37	19.43	78.84	451.91
Montane hardwood–conifer	70.68	0.99	150.42	136.54	111.63	179.48	649.76
Montane riparian	4.16	6.67	26.16	13.91	1.53	5.52	57.94
Ponderosa pine	215.11	30.72	188.19	161.64	49.56	122.07	767.30
Riverine	0.00	0.88	5.24	15.43	1.41	0.00	22.96
Urban	21.95	0.00	1.95	7.96	0.00	1.26	33.14
Total	**460.37**	**91.67**	**730.72**	**446.49**	**242.92**	**519.90**	**2492.07**

Note:
[1]Acreage values are approximate.

Table 13-2. Summary of Wildlife Habitats in the Relocation Areas

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Annual grassland	4.79	0.00	26.46	9.75	0.84	0.23	42.07
Barren	22.37	0.00	72.18	29.71	11.53	12.06	147.86
Blue oak–foothill pine	1.91	0.00	0.00	0.00	0.00	7.24	9.16
Blue oak woodland	0.00	0.00	0.00	3.68	0.00	0.92	4.59
Closed-cone pine–cypress	0.11	0.00	41.98	9.63	1.94	12.50	66.15
Douglas-fir	0.00	0.00	0.00	3.02	0.00	0.00	3.02
Mixed chaparral	12.65	0.00	56.11	26.92	4.44	33.98	134.11
Montane hardwood	35.81	0.00	137.77	148.13	6.34	0.13	328.17
Montane hardwood–conifer	104.31	0.00	117.35	221.40	29.04	30.09	502.19
Montane riparian	0.34	0.00	1.35	3.08	0.23	0.02	5.02
Ponderosa pine	156.24	0.00	398.26	272.10	43.08	22.09	891.77
Riverine	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Urban	20.66	0.00	228.60	0.48	0.00	0.57	250.30
Total	**359.20**	**0.00**	**1080.05**	**727.90**	**97.44**	**119.83**	**2384.42**

Note:
[1] Acreage values are approximate.

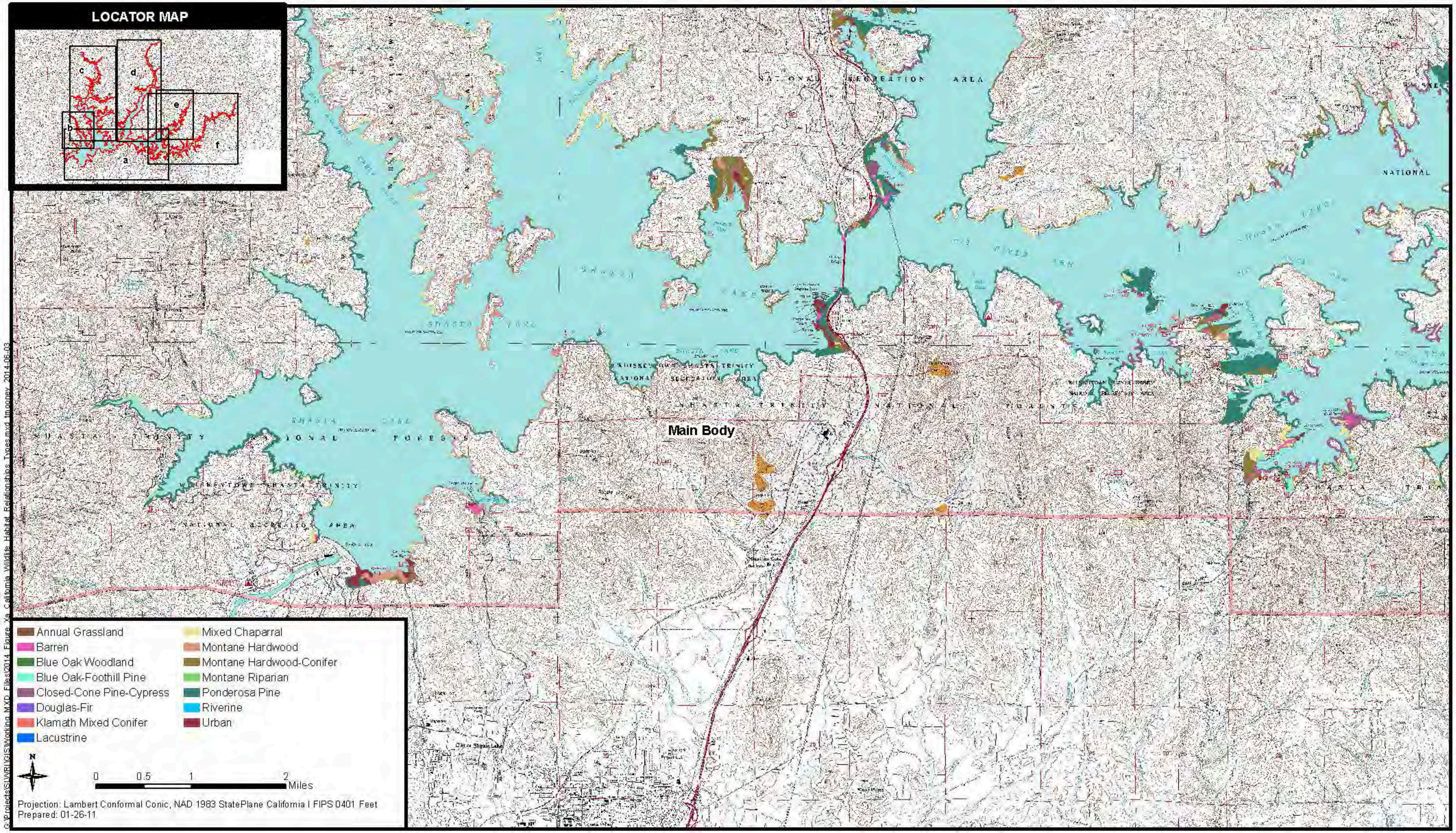


Figure 13-3a. California Wildlife Habitat Relationship Types

This page left blank intentionally.

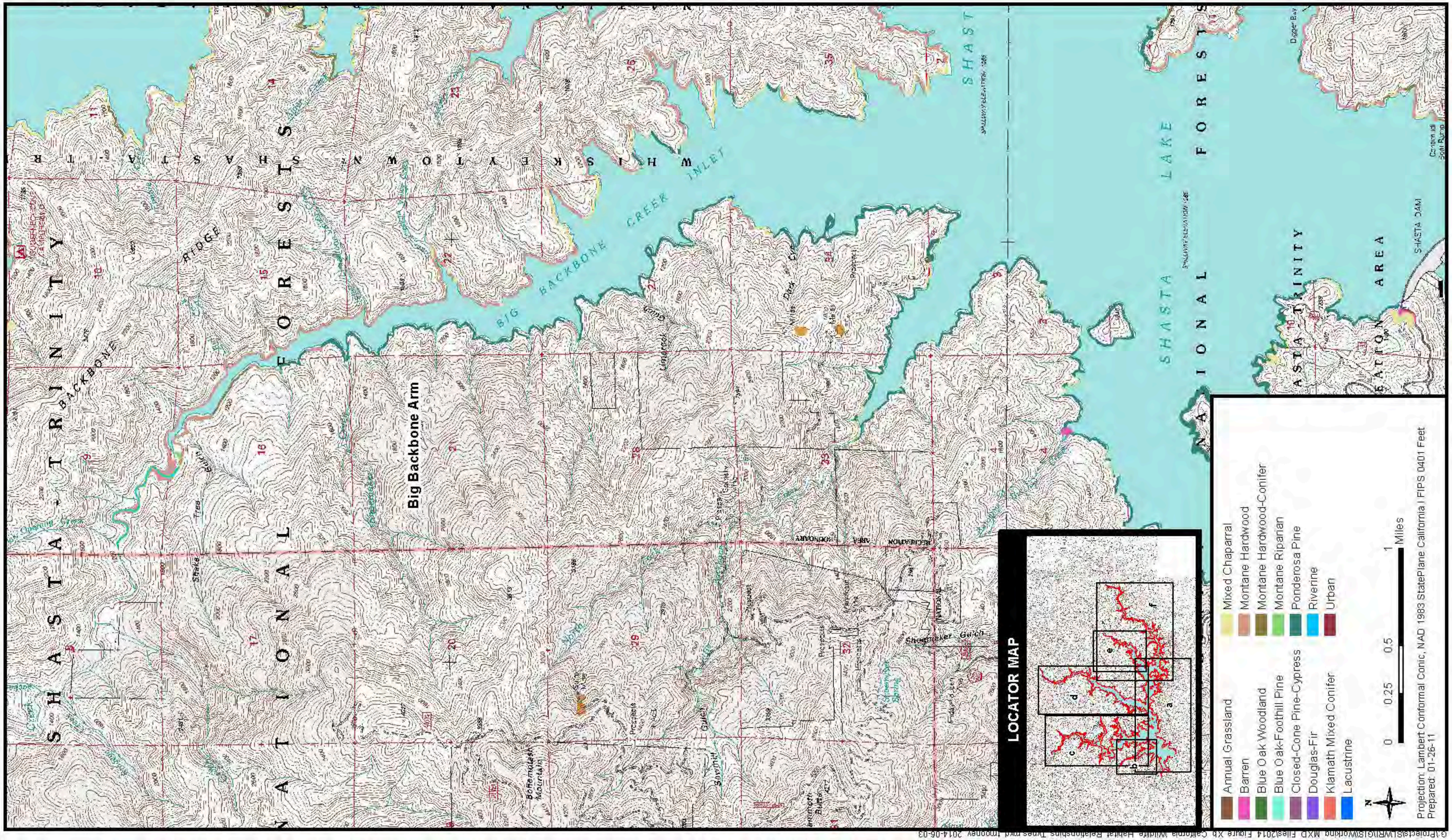


Figure 13-3b. California Wildlife Habitat Relationship Types

This page left blank intentionally.

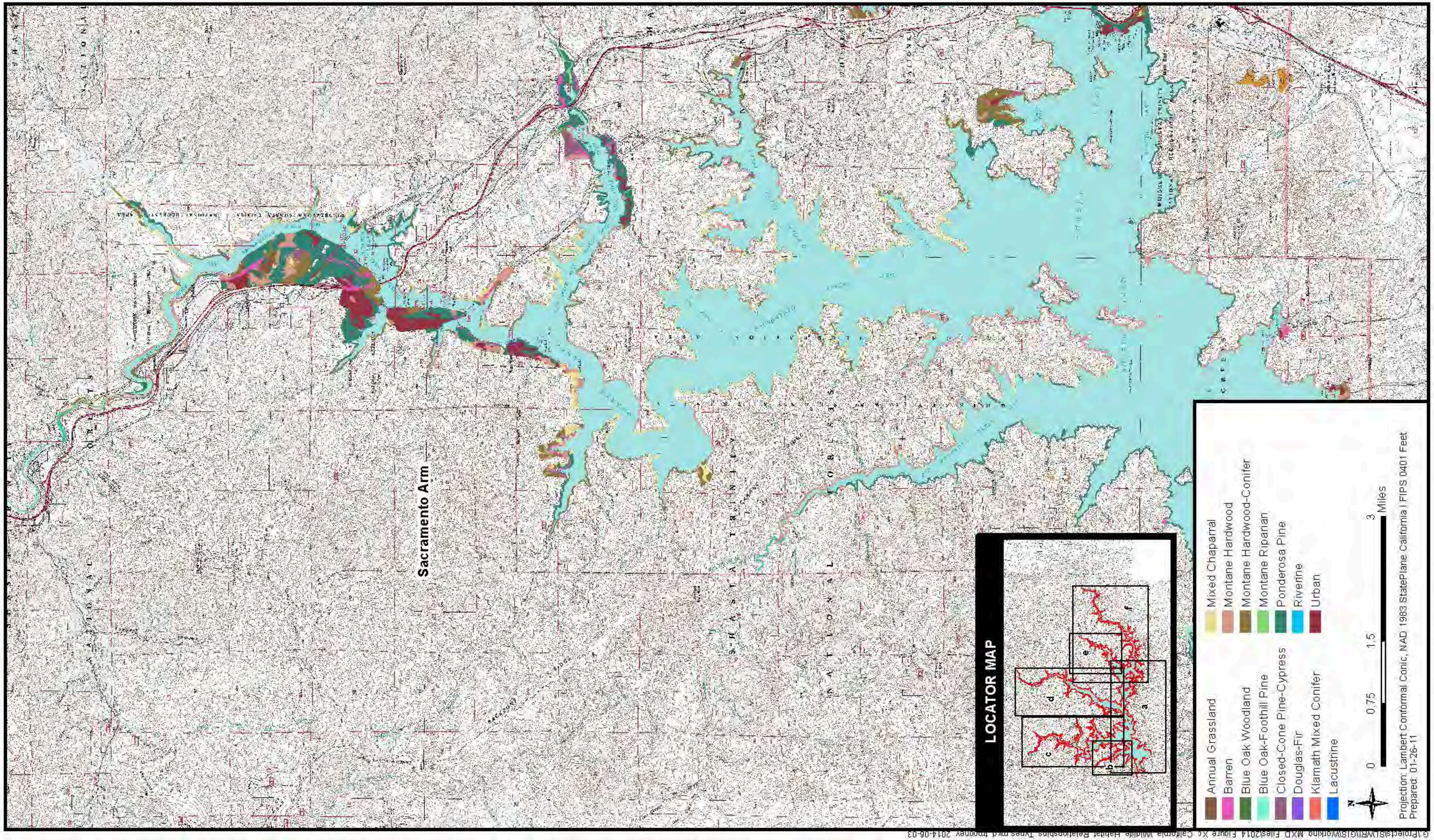


Figure 13-3c. California Wildlife Habitat Relationship Types

This page left blank intentionally.

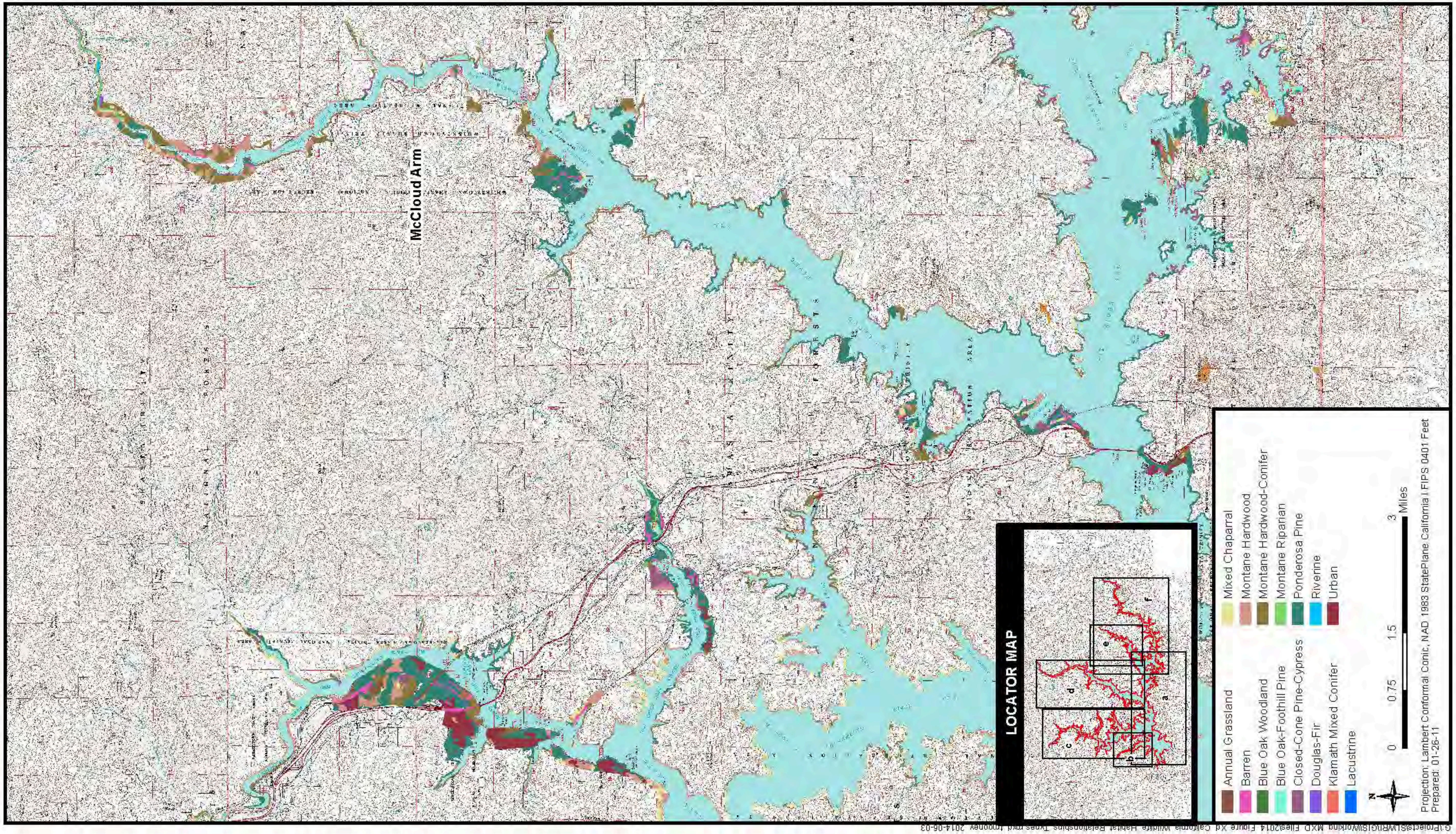


Figure 13-3d. California Wildlife Habitat Relationship Types

This page left blank intentionally.

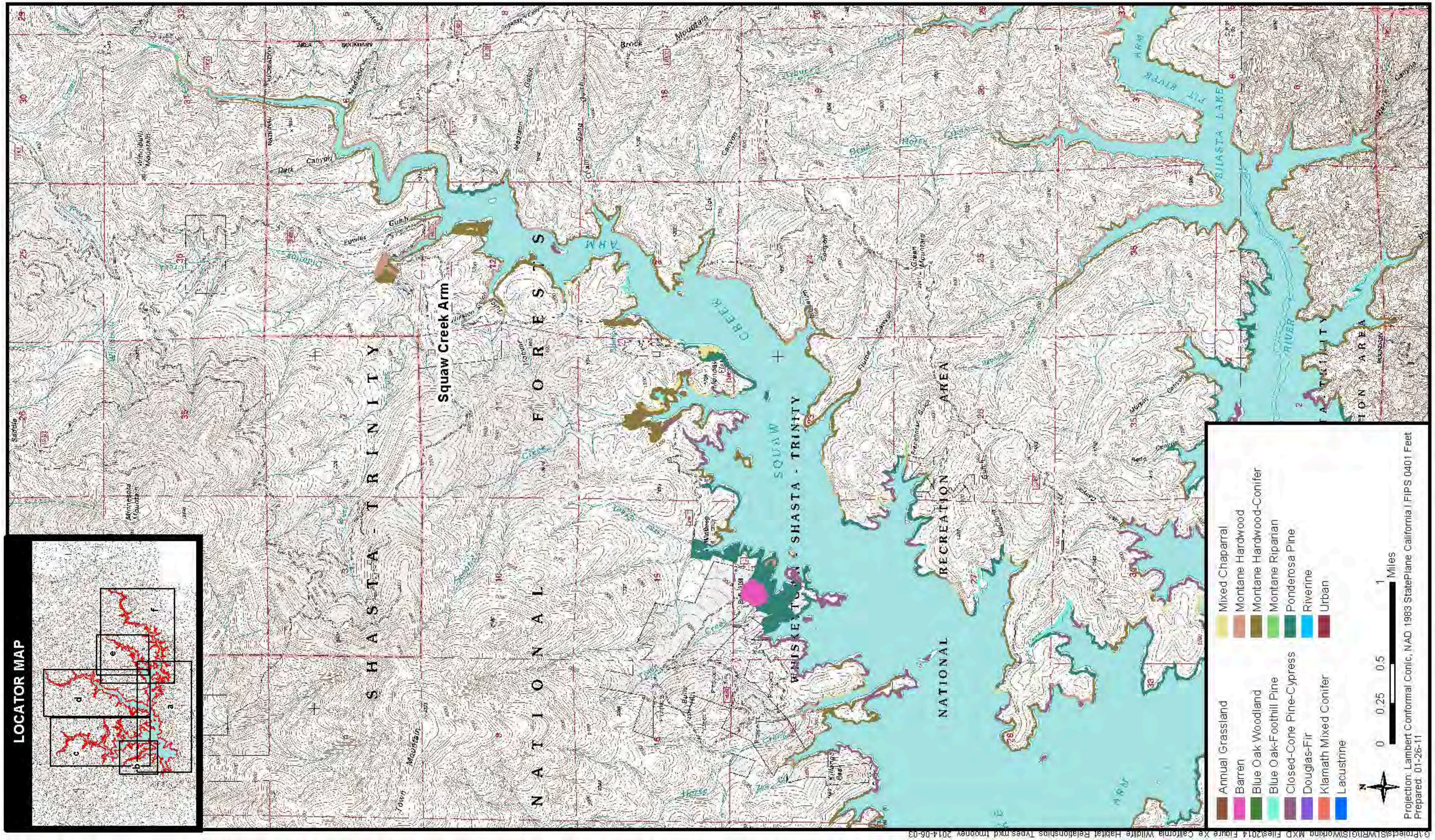


Figure 13-3e. California Wildlife Habitat Relationship Types

This page left blank intentionally.

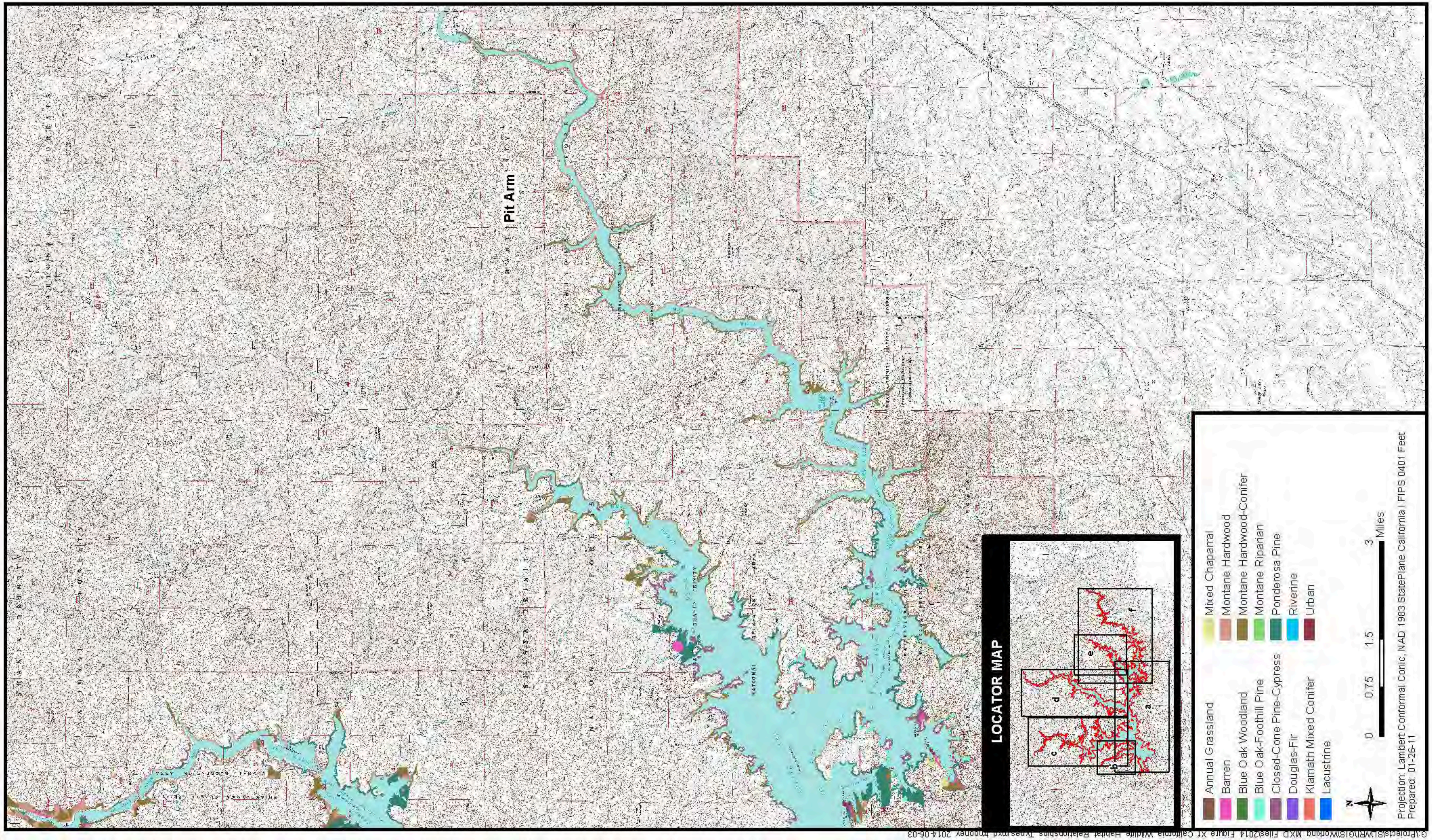


Figure 13-3f. California Wildlife Habitat Relationship Types

This page left blank intentionally.

Annual Grassland Annual grassland is uncommon in the Shasta Lake and vicinity portion of the primary study area and occurs as small inclusions in other more prevalent plant series types or in areas subjected to previous disturbance. Dominant species include wild oat (*Avena fatua*), cheatgrass (*Bromus tectorum*), ripgut (*B. diandrus*), yellow star-thistle (*Centaurea solstitialis*), squirreltail (*Elymus elymoides*), and European hairgrass (*Aira caryophyllea*). Grassland bird species, such as the mourning dove (*Zenaida macroura*), savannah sparrow (*Passerculus sandwichensis*), and white-crowned sparrow (*Zonotrichia leucophrys*), as well as rodents, such as the California ground squirrel (*Spermophilus beecheyi*), Botta's pocket gopher (*Thomomys bottae*), and deer mouse (*Peromyscus maniculatus*), may forage on the seed crop this community provides. These species, in turn, attract predators, such as the gopher snake (*Pituophis melanoleucus*), American kestrel (*Falco sparverius*), red-tailed hawk (*Buteo jamaicensis*), and coyote. Reptile species expected to inhabit this area include the western fence lizard (*Sceloporus occidentalis*), western skink (*Eumeces skiltonianus*), western rattlesnake (*Crotalus viridis*), and yellow-bellied racer (*Coluber constrictor*).

Barren Barren habitat consists mainly of human-made features without vegetation scattered throughout the Shasta Lake and vicinity portion of the primary study area, including boat ramps, parking lots, and roads. Other barren habitats include a large gravel plain feature at the confluence of Butcher Creek and Shasta Lake (Main Body) and a sealed riprap feature adjacent to Interstate 5 near the upper Sacramento Arm and Shasta Lake confluence. Vegetation is usually not present, although a sparse cover of grasses/forbs or weedy species may be present. Barren habitat has limited value for wildlife; however, many species in adjacent habitats may use these areas occasionally as opportunities arise, such as for feeding. Also, open nesting species, such as killdeer (*Charadrius vociferus*), may use some barren surfaces for nesting.

Blue Oak Woodland Blue oak woodland occurs mainly as small inclusions within other more prevalent habitats; however, moderate-sized stands also occur. This habitat occurs at scattered locations along the Main Body, McCloud Arm, and Pit Arm. Blue oak woodland is characterized by a moderate overstory of blue oak *(Quercus douglasii)* with a dense herbaceous understory. Oak woodlands produce acorns used as forage by a variety of species, including acorn woodpeckers (*Melanerpes formicivorus*), western scrub-jays (*Aphelocoma californica*), turkey (*Meleagris gallopavo*), western gray squirrels (*Sciurus griseus*), and black-tailed deer (*Odocoileus hemionus columbianus*). Snags and live trees containing cavities provide nesting habitat for species such as the western bluebird (*Sialia mexicana*), tree swallow (*Tachycineta bicolor*), American kestrel, and northern flicker (*Colaptes auratus*), as well as roost sites for bats and denning sites for mammals, such as the raccoon, Virginia opossum (*Didelphis virginiana*), and gray fox (*Urocyon cinereoargenteus*). Raptors, including the red-tailed hawk and great horned owl, also nest in these woodlands. Amphibian and reptile species found here include the Pacific chorus frog (*Pseudacris regilla*), bullfrog (*Rana catesbeiana*), western fence lizard, southern alligator lizard (*Elgaria multicarinata*), western terrestrial garter snake (*Thamnophis elegans*), common garter snake (*Thamnophis sirtalis*), and western rattlesnake.

Blue Oak–Foothill Pine Blue oak–foothill pine habitat also occurs mainly as small inclusions within other more prevalent habitats in the Shasta Lake and vicinity portion of the primary study area; however, moderate-sized stands also occur. This habitat is found in the Main Body, Squaw Creek Arm, and Pit Arm. Species composition is similar to the blue oak woodland habitat; however, gray pine and a shrub component are more common. Dominant overstory species include blue oak, California black oak *(Quercus kelloggii),* valley oak *(Quercus lobata),* interior live oak *(Quercus wislizenii),* and gray pine *(Pinus sabiniana).* Common shrubs observed in this habitat include white leaf manzanita *(Arctostaphylos viscida),* buck brush *(Ceanothus cuneatus),* poison oak *(Toxicodendron diversilobum),* coffee berry *(Frangula californica),* snowdrop bush *(Styrax officinalis),* wild mock orange *(Philadelphus lewisii),* deer brush *(Ceanothus integerrimus),* and California buckeye *(Aesculus californica).* Common grasses and forbs observed in this vegetation habitat include pussy ears *(Calochortus tolmiei),* Pacific hounds tongue *(Cynoglossum grande),* slender wild oat, and soaproot *(Chlorogalum pomeridianum).* Lianas of Dutchman's pipe *(Aristolochia californica)* and chaparral clematis *(Clematis lasiantha)* shroud shrubs and often grow into the tree canopy.

The blue oak–foothill pine community provides breeding habitat for a large variety of wildlife species, although no species is completely dependent on it for breeding, feeding, or cover. Many of the species found in blue oak habitat are also found here. Acorns and gray pine seeds are an important resource for many of the species using this habitat, such as the acorn woodpecker, western scrub-jay, and western gray squirrel. The newly emerged leaves of oaks in the spring support an abundance of insects that attract migrating and nesting warblers, vireos, flycatchers, and other insectivorous birds. In addition, the shrubs provide habitat for birds, such as the spotted towhee (*Pipilo maculatus*), California towhee (*Pipilo crissalis*), wrentit (*Chamaea fasciata*), and blue-gray gnatcatcher (*Polioptila caerulea*). Characteristic reptiles and amphibians include western toads (*Bufo boreas*), a wide variety of snakes (common garter snakes, California whipsnakes (*Masticophis lateralis*), gopher snakes, and western rattlesnakes), western skinks, southern alligator lizards, and western fence lizards.

Closed-Cone Pine–Cypress Closed-cone pine–cypress consists of open to dense knobcone pine (*Pinus contorta*) stands. This habitat is scattered throughout all portions of the Shasta Lake and vicinity portion of the primary study area and often occurs in disturbed areas, including areas subject to wildfires and historic mining activities. Dominant species include knobcone pine, with occasional canyon live oak (*Quercus chrysolepis*), California black oak, ponderosa pine, and gray pine. The shrub layer is moderate to dense and is dominated by white leaf manzanita and poison oak. The ground cover varies and is dominated by various grasses and forbs. Numerous game and nongame species make use of this habitat for feeding and cover. Steller's jays (*Cyanocitta stelleri*) and western scrub-jays, downy woodpeckers (*Picoides pubescens*), and western gray squirrels extract seeds from partially opened cones. The great horned owl and red-tailed hawk are among the few species known to use this habitat for breeding.

Douglas-Fir As a habitat type, Douglas-fir is uncommon in the Shasta Lake and vicinity portion of the primary study area. This habitat type occurs in the upper portion of the McCloud Arm. Douglas-fir is characterized by moderate to dense conifer stands dominated by Douglas-fir (*Pseudotsuga menziesii*), with occasional ponderosa pine (*Pinus ponderosa*), sugar pine (*Pinus lambertiana*), incense cedar (*Calocedrus decurrens*), canyon live oak, and California black oak. Associated understory species vary and include Pacific dogwood (*Cornus nuttallii*), mock orange (*Philadelphus lewisii*), poison oak, snowdrop bush, and white leaf manzanita. The ground layer ranges from open to moderate and is dominated by various grasses and forbs. The multilayered vegetation in the Douglas-fir community supports a variety of wildlife species. A significant feature of the community is the presence of cavity-bearing trees. Mature, fire-damaged, and wind-damaged forests typically contain snags (dead trees that are still standing), which are a valuable resource for birds and mammals that prefer nest and den sites in cavities, such as the flammulated owl (*Otus flammeolus*) and northern pygmy owl (*Glaucidium gnoma*). Snags also support wood-boring insects that provide food for bark-gleaning insectivorous birds, such as the brown creeper (*Certhia americana*). Other birds foraging and/or breeding in this habitat include the sharp-shinned hawk (*Accipiter striatus*), American peregrine falcon, mountain quail, western wood-pewee (*Contopus sordidulus*), and western tanager (*Piranga ludoviciana*). Mammals found in this habitat include the long-eared myotis (*Myotis evotis*), western red bat (*Lasiurus blossevillii*), northern flying squirrel (*Glaucomys sabrinus*), and bobcat (*Lynx rufus*).

Klamath Mixed Conifer Klamath mixed conifer is an uncommon habitat type in the Shasta Lake and vicinity portion of the primary study area. This habitat type occurs in the upper portion of the Pit Arm, and in scattered locations in the watershed above the Shasta Lake and vicinity portion of the primary study area. Klamath mixed conifer is characterized by conifer stands dominated by Douglas-fir, ponderosa pine, sugar pine, with occasional incense cedar. Dominant hardwoods include canyon live oak, California black oak, and Pacific madrone (*Arbutus menziesii*). Associated understory species vary and include Pacific dogwood, mock orange, poison oak, and snowberry (*Symphoricarpos* sp.). The ground layer ranges from open to moderate and is dominated by various grasses and forbs. These forest stands are generally complex structurally, tend to grow on cooler northerly aspect slopes, and support similar wildlife species as the Douglas-fir habitat.

Lacustrine Lacustrine habitat consists of the area regularly inundated by Shasta Lake (i.e., areas up to and below the 1,070-foot elevation). Most of this area is barren of vegetation and is characterized as exposed soil and/or rock. Portions of the lacustrine habitat do support vegetation during draw-down periods, including woody riparian species, such as black willow, button willow, Fremont cottonwood, and various grasses and forbs.

Mixed Chaparral Mixed chaparral is a common habitat type and is scattered throughout all portions of the Shasta Lake and vicinity portion of the primary study area. This habitat often occurs on exposed slopes and/or in disturbed areas, including areas subject to wildfires and historic mining activities. Mixed chaparral is typically characterized by dense shrub stands dominated by white leaf manzanita, buck brush, toyon *(Heteromeles arbutifolia),* California buckeye, Brewer's oak *(Quercus garryana* var. *breweri),* California bay *(Umbellularia californica),* interior live oak, Lemmon's ceanothus *(Ceanothus lemmonii),* birch-leaf mountain mahogany *(Cercocarpus betuloides),* holly-leaf redberry *(Rhamnus ilicifolia),* yerba santa *(Eriodictyon californicum),* and poison oak. Few herbaceous plants occur in this habitat. Mixed chaparral provides habitat for a wide variety of wildlife species. It provides seeds, fruit, and protection from predators and harsh weather. In addition, it provides singing, roosting, and nesting sites for many species of birds, including the California quail (*Callipepla californica*), wrentit, and Bewick's wren (*Thryomanes bewickii*). Mammals common in this habitat include the black-tailed hare (*Lepus californicus*), gray fox, coyote, and deer mouse. Reptiles that make use of this habitat include the western fence lizard and southern alligator lizard.

Montane Hardwood Montane hardwood is a common tree habitat type and is scattered throughout all portions of the Shasta Lake and vicinity portion of the primary study area. The montane hardwood stands are typically characterized by moderate to dense stands of California black oak, canyon live oak, and occasional interior live oak. The understory is variable, although often sparse in the evergreen (live oak) stands because of a typically dense overstory canopy. Mast crops provided by montane hardwood forests are an important food resource for many species, including the acorn woodpecker, Steller's jay, mountain quail (*Oreortyx pictus*), western gray squirrel, and black-tailed deer. In addition, cavities in mature trees provide nesting and denning habitat for species such as the northern flicker, western screech owl (*Otus kennicottii*), American kestrel, and Virginia opossum. In moist areas, many amphibians and reptiles are found in the duff layer, including ensatina (salamander) (*Ensatina eschscholtzii*) and western skink.

Montane Hardwood–Conifer Montane hardwood–conifer is a common tree habitat type and is scattered throughout all portions of the Shasta Lake and vicinity portion of the primary study area. Montane hardwood–conifer is a complex forest type generally characterized by a complex of hardwood and conifer tree species. Stand composition varies, depending on numerous physical and geographic factors, and can include California black oak, canyon live oak, interior live oak, Oregon white oak (*Quercus garryana*), gray pine, ponderosa pine, Douglas-fir, sugar pine, and knobcone pine. Understory species are generally moderate to dense and include white leaf manzanita, buck brush, California buckeye, western redbud *(Cercis occidentalis)*, California bay, poison oak, birch-leaf mountain mahogany, Brewer's oak, and snowdrop bush. The ground layer varies and is dominated by various grasses and forbs, including pussy ears, soaproot, Pacific hound's tongue, and slender wild oat.

The variability of the canopy cover and understory vegetation makes montane hardwood–conifer habitat suitable for numerous species of wildlife. Hollow trees and logs provide denning sites for mammals, such as the coyote and gray fox, and cavities in mature trees are used by cavity-dwelling species, such as the acorn woodpecker, violet-green swallow (*Tachycineta thalassina*), northern flicker, great horned owl, raccoon, and California myotis (*Myotis californicus*). In addition, raptors, such as the red-tailed hawk, construct nests in the upper canopy of mature trees. Moreover, mast crops and conifer seeds are an important food source for many birds and mammals, including the Steller's jay, acorn woodpecker, California quail, black-tailed deer, and western gray squirrel. In moist areas, many amphibians and reptiles, including ensatina and western fence lizards, inhabit the duff layer. Snakes, including the western rattlesnake and sharp-tailed snake (*Contia tenuis*), also are found in this habitat.

Montane Riparian Montane riparian is the dominant riparian habitat type and is scattered throughout all portions of the Shasta Lake and vicinity portion of the primary study area. Montane riparian habitat occurs as thin stringers and large patches along most stream corridors and is characterized as a sparse overstory of white alder (*Alnus rhombifolia*), Fremont cottonwood (*Populus fremontii*), or big leaf maple (*Acer macrophyllum*), along with a fairly dense mid-story and herbaceous layer. The mid-story is dominated by red osier dogwood (*Cornus sericea*), arroyo willow (*Salix lasiolepis*), narrow-leafed willow (*S. exigua*), red willow *(S. laevigata*), spicebush (*Calycanthus occidentalis*), mock orange, button willow (*Cephalanthus occidentalis*), American dogwood (*Cornus cericea*), California ash (*Fraxinus dipetala*), and mugwort (*Artemesia douglasiana*). Brambles of Himalayan blackberry (*Rubus armeniacus*) and California blackberry (*R. ursinus*) often engulf broader, low-gradient riparian areas. Lianas, including California grape and greenbriar (*Smilax californica*), grow into the canopy.

Riparian habitats are among the most important wildlife habitats because of their high floristic and structural diversity, high biomass (and therefore high food abundance), and high water availability. In addition to providing breeding, foraging, and roosting habitat for a diverse array of animals, riparian habitats also provide movement corridors for some species, connecting a variety of habitats throughout the region.

The leaf litter, fallen tree branches, and logs associated with the riparian community in the study area provide cover for the western toad and Pacific chorus frog. The western fence lizard, western skink, and southern alligator lizard are also expected to occur here. Common species nesting and foraging primarily in the riparian tree canopy include the bushtit (*Psaltriparus minimus*), white-breasted nuthatch (*Sitta carolinensis*), and Nuttall's woodpecker (*Picoides nuttallii*). Other resident species, such as the spotted towhee and song sparrow (*Melospiza melodia*), nest and forage on or very close to the ground, usually in dense vegetation. A variety of mammals also inhabit riparian communities, including the deer mouse, raccoon, Virginia opossum, and several bat species.

Ponderosa Pine Ponderosa pine is the most common conifer habitat type in the Shasta Lake and vicinity portion of the primary study area and is scattered throughout all portions of the area. This habitat is characterized by open to dense conifer stands dominated by ponderosa pine. Associated species include occasional Douglas-fir, sugar pine, incense cedar, canyon live oak, and California black oak. Associated understory species vary and include redbud, buck brush, mock orange, poison oak, snowdrop bush, and white leaf manzanita. The ground layer ranges from open to moderate and is dominated by various grasses and forbs.

Ponderosa pine needles, cones, buds, pollen, twigs, seeds, and associated fungi and insects provide food for many species of birds and mammals, including the mountain quail, western gray squirrel, black-tailed deer, Allen's chipmunk (*Tamias senex*), and black bear (*Ursus americanus*). Mature trees provide nesting habitat for raptors, such as the bald eagle (*Haliaeetus leucocephalus*), osprey (*Pandion haliaetus*), sharp-shinned hawk, and red-tailed hawk, and snags and hollow logs provide shelter for species such as the Virginia opossum, western spotted skunk (*Spilogale gracilis*), and several bat species.

Riverine Riverine habitat includes the free-flowing portions of the rivers and larger streams tributary to Shasta Lake. The riverine habitat is highly variable and ranges from moderately to well-confined stream reaches with low to steep gradient. Most riverine habitat is dominated by run-and-riffle habitats, with bedrock, boulder, cobble, gravel, and sand substrates. The vegetation in the active stream channel is sparse, with occasional clumps of torrent sedge (*Carex nudata*) and Indian rhubarb (*Darmera peltata*).

Riverine areas provide habitat for numerous fish, including rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*), smallmouth bass (*Micropterus dolomieu*), and riffle sculpin (*Cottus gulosus*). Aquatic wildlife species include the foothill yellow-legged frog (*Rana boylii*), aquatic garter snake (*Thamnophis atratus*), and the aquatic phase of the rough-skinned newt (*Taricha granulosa granulosa*). Birds present include the American dipper (*Cinclus mexicanus*), common merganser (*Mergus merganser*), and belted kingfisher (*Ceryle alcyon*). Many mammals in the surrounding upland habitats use the riverine areas, including raccoon, gray fox, black-tailed deer, and many bat species.

Urban Urban habitat consists of various human-made features scattered throughout the Shasta Lake and vicinity portion of the primary study area, including resorts and a portion of the visitor center complex at Shasta Dam. These features are typically a combination of buildings, pavement areas with manicured landscaping, and lawns. The wildlife species most often associated with urban areas are those that are most tolerant of periodic human disturbances, including several introduced species, such as European starling (*Sturnus vulgaris*), rock dove (*Columba livia*), and house mouse (*Mus musculus*). Native species that are able to use these habitats include the western fence lizard, American robin (*Turdus migratorius*), Brewer's blackbird (*Euphagus cyanocephalus*), northern mockingbird (*Mimus polyglottos*), mourning dove, house finch (*Carpodacus mexicanus*), California ground squirrel, black-tailed hare, and striped skunk (*Mephitis mephitis*). In addition, bats that forage in nearby habitats may make use of small cavities around the eaves of structures.

Upper Sacramento River (Shasta Dam to Red Bluff)

The following section provides a description of the wildlife habitats that exist along the Sacramento River throughout the primary study area, and a detailed discussion of potential Sacramento River downstream habitat restorations areas.

Important wildlife habitat is found throughout the upper Sacramento River portion of the primary study area, and large contiguous blocks that contain multiple habitat types have the potential to support the highest wildlife diversity and abundance. Overall, the quantity and variety of wildlife species now inhabiting the area have been reduced since agricultural and residential development permanently removed much of the native and natural habitat. Most affected have been wildlife species associated with riparian habitats, which have declined substantially and been highly altered by land use, water resources development, and land management practices. Wildlife species associated with grassland and oak woodland habitats have also been affected by habitat loss resulting from habitat conversions to residential, commercial, and agricultural uses; cattle grazing; and other compounding factors, such as lack of oak regeneration, spread of Sudden Oak Death Syndrome, and competition from invasive species. The region also supports a variety of nonnative plant and animal species, some of which are detrimental to survival of native species.

Habitats present in this portion of the primary study area are riparian woodland, riparian scrub, oak woodland, chaparral, annual grassland, agriculture, and urban. (See the *Wildlife Resources Technical Report* for a description of the plant and wildlife species typical of these habitats.) Riparian habitat has been designated by the CDFW as a sensitive habitat in California because of its limited abundance and high value to wildlife.

Potential Sacramento River Downstream Habitat Restoration Areas As a component of the SLWRI, Reclamation proposes to restore and/or enhance riparian and riverine habitats at six locations along the lower Sacramento River below Shasta Dam. These six locations occur generally between the city of Redding and Reading Island, Shasta County, California. The purpose of the restoration effort is to improve spawning and rearing habitat for anadromous fish occurring in the Sacramento River. These six locations are referred to as the potential Sacramento River downstream habitat restoration areas (Figure 13-2).

The potential Sacramento River downstream habitat restoration areas are characterized by habitats typical of riparian and riverine areas along the Sacramento River below Shasta Dam. These habitats were also mapped and classified using the Guide to Wildlife Habitats of California (Mayer and Laudenslayer 1988). Habitats present in the potential Sacramento River downstream habitat restoration areas are summarized in Table 13-3, and shown in Figures 13-4a through 13-4f. General habitat descriptions for these locations are also described below.

Table 13-3. Summary of Wildlife Habitats in the Potential Sacramento River Downstream Habitat Restoration Areas

Habitat	Area (Acres[1])						
	Henderson	Tobiasson Island	Shea Island Complex	Kapusta Island	Anderson River Park	Reading Island	Total
Annual grassland	2.50	13.73	2.61	18.15	7.83	0.00	44.82
Barren	0.31	1.10	0.00	0.00	0.55	0.00	1.96
Freshwater emergent wetland	3.73	0.28	0.54	0.43	11.05	15.33	31.36
Mixed chaparral	0.00	0.00	0.00	0.00	2.80	0.00	2.80
Orchard	0.00	0.00	0.00	0.00	0.00	0.55	0.55
Riverine	0.66	1.33	3.45	8.07	0.00	0.47	13.98
Valley-foothill riparian	13.12	9.06	28.97	25.08	57.90	24.78	158.90
Valley oak woodland	0.00	13.26	0.00	13.33	26.85	50.48	103.92
Total	20.32	38.76	35.57	65.06	106.96	91.61	358.29

Note:
[1]Acreage values are approximate.

Figure 13-4a. California Wildlife Habitat Relationship Types – Henderson Open Space

This page left blank intentionally.

Figure 13-4b. California Wildlife Habitat Relationship Types – Tobiasson Island

This page left blank intentionally.

Figure 13-4c. California Wildlife Habitat Relationship Types – Shea Island Complex

This page left blank intentionally.

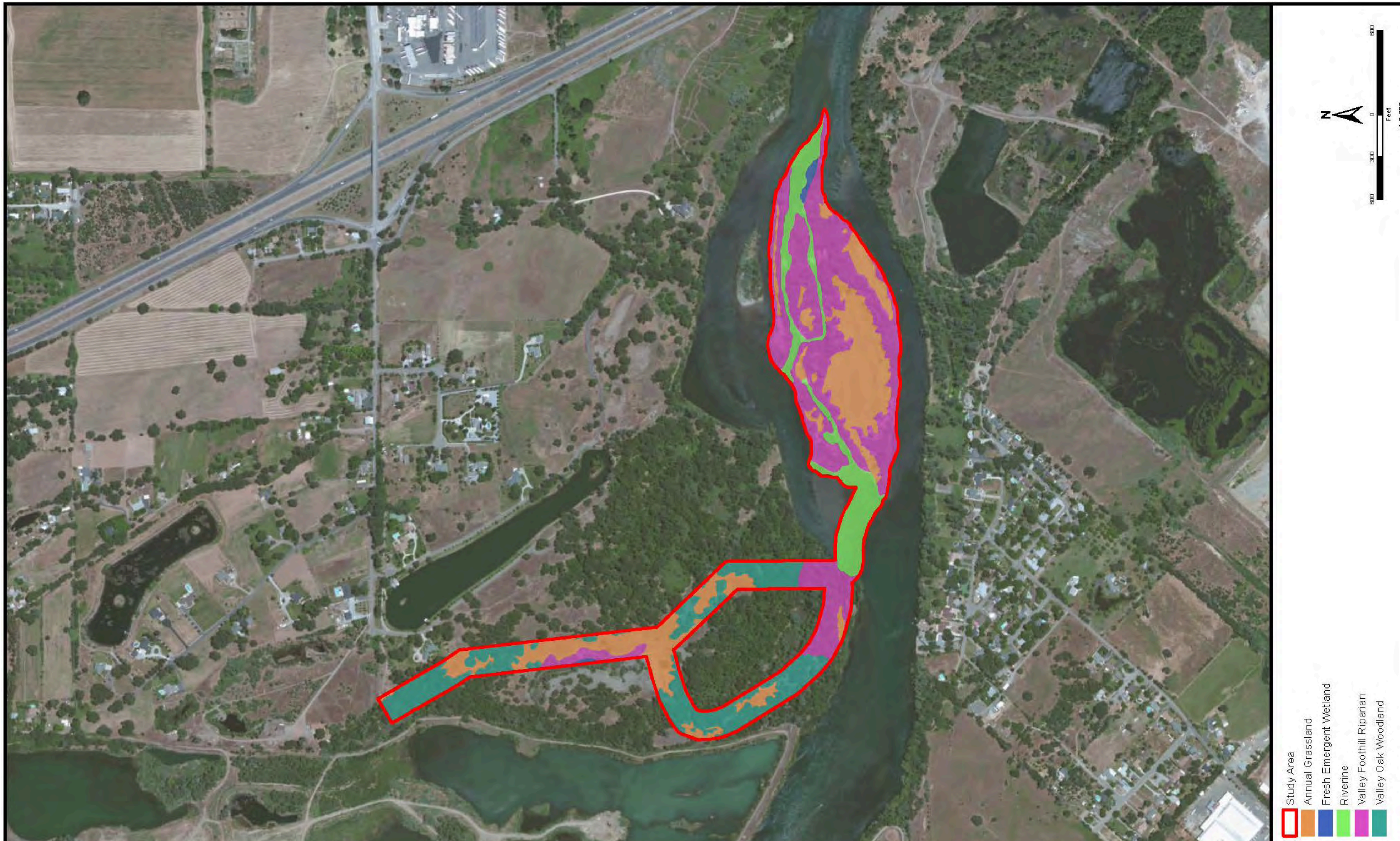


Figure 13-4d. California Wildlife Habitat Relationship Types – Kapusta Island

This page left blank intentionally.

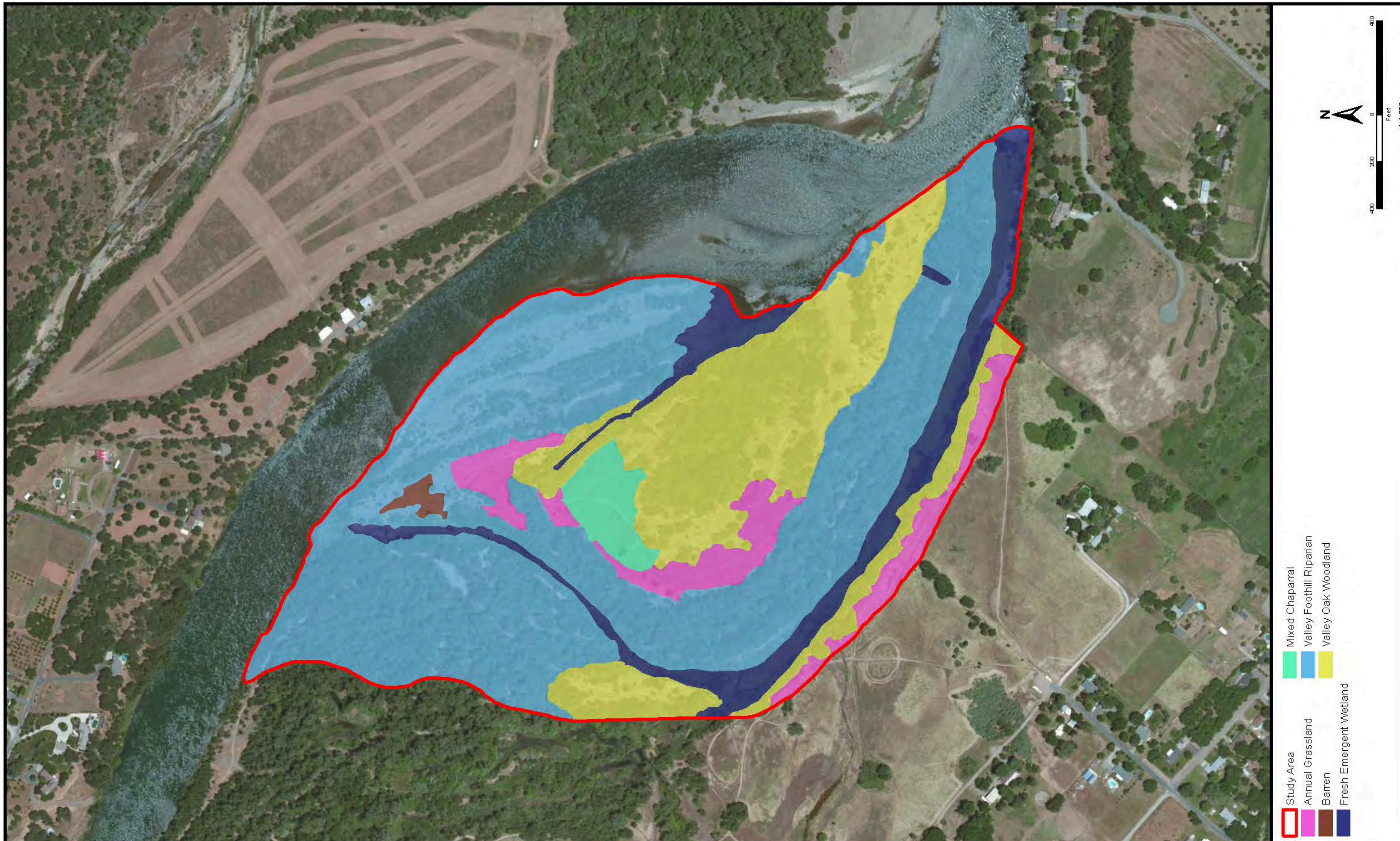


Figure 13-4e. California Wildlife Habitat Relationship Types – Anderson River Park

This page left blank intentionally.

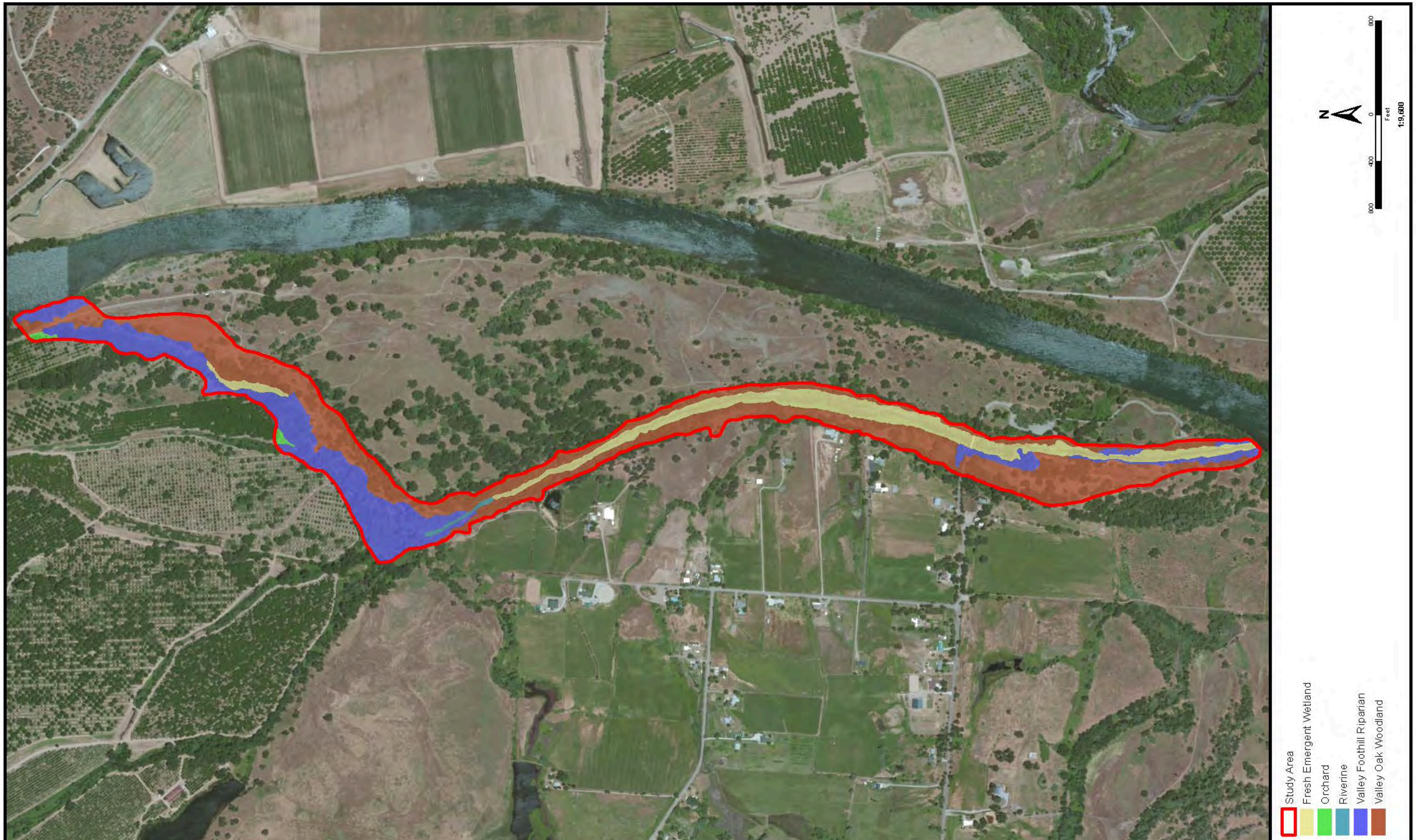


Figure 13-4f. California Wildlife Habitat Relationship Types – Reading Island

This page left blank intentionally.

Many of the same wildlife habitats found in the Shasta Lake and vicinity portion of the primary study area also occur in the potential Sacramento River habitat restoration areas. However, the species composition, structure, and overall function of these areas are significantly different, as these areas are situated in a separate geographic setting and region. Habitats occurring in the potential Sacramento River habitat restoration areas include annual grassland, barren, freshwater emergent wetland, mixed chaparral, orchard, riverine, valley-foothill riparian, and valley oak woodland.

Annual Grassland Annual grasslands are uncommon in the potential Sacramento River habitat restoration areas and occur as open ruderal areas and vegetated gravel bars. This plant community is characterized by moderate to dense cover of annual grasses and forbs including black mustard (*Brassica nigra*), California poppy (*Eschscholzia californica*), ripgut grass (*Bromus diandrus*), soft chess (*Bromus hordeaceus*), wild oat (*Avena barbata*), rose clover (*Trifolium hirtum*), long beaked storks bill (*Erodium botrys*), turkey mullein (*Croton setigeris*), Oregon golden aster (*Heterotheca oregona*), and tall sock-destroyer (*Torilis arvensis*).

Barren Barren habitat occurs on gravel bars and is characterized by open areas of gravel and cobble substrates. Vegetation is typically absent, although in some barren areas sparse opportunistic grasses/forbs or weedy species may occur.

Freshwater Emergent Wetland Freshwater emergent wetlands occur along the margins of backwater sloughs and other wetland features, and as small inclusions in valley-foothill riparian habitats. These wetlands are characterized by dense stands of broadleaf cattail (*Typha latifolia*), with reed canarygrass (*Phalaris arundinacea*), horsetail (*Equisetum* sp.), smartweed (*Persicaria* sp.), sedges (*Carex* spp.), rushes (*Juncus* spp.), and dallisgrass (*Paspalum dilatatum*). Submergent vegetation dominated by parrot's feather (*Myriophyllum aquaticum*) and water primrose (*Ludwigia peploides*) grow in the deep water portions of the wetlands.

Mixed Chaparral Mixed chaparral is uncommon in the potential Sacramento River habitat restoration areas and only occurs at the Anderson River Park site. This habitat consists of shrub patches in open rocky areas in the central portion of the study area dominated by California yerba santa (*Eriodictyon californicum*) and wright's buckwheat (*Eriogonum wrightii*). Other associated species include Oregon golden aster, naked buckwheat (*Eriogonum nudum*), slender wild oat, mousetail, ripgut grass, soft chess, and red brome (*Bromus madritensis* ssp. *rubens*).

Orchard Orchard habitat is uncommon in the potential Sacramento River habitat restoration areas and only occurs at the Reading Island site. This habitat consists of a small portion of a walnut orchard extending into a portion of the northern site boundary. The walnut orchard is mature and well maintained.

Vegetation includes an overstory of walnut trees and ground cover of various grasses and forbs.

Riverine Riverine habitat occurs at each potential Sacramento River habitat restoration area and consists of portions of active Sacramento River channel within and/or around each site. The riverbed is dominated by primarily gravel, cobble, and boulder substrates.

Valley-foothill Riparian Valley-foothill riparian is the dominant habitat in the potential Sacramento River habitat restoration areas and occurs as moderate to dense stands of mainly riparian trees and shrubs. Many tree and shrub species occur including Fremont cottonwood (*Populus fremontii*), valley oak (*Quercus lobata*), Oregon ash (*Fraxinus latifolia*), white alder (*Alnus rhombifolia*), narrowleaf willow (*Salix exigua*), shining willow (*Salix lasiandra*), Goodding's black willow (*Salix gooddingii*), black locust (*Robinia pseudoacacia*), and silver wattle (*Acacia dealbata*). Understory vegetation is moderate to dense and includes Himalayan blackberry (*Rubus armeniacus*), California grape (*Vitis californica*), Santa Barbara sedge (*Carex barbarae*), giant reed (*Arundo donax*), mugwort (*Artemisia douglasii*), horsetail, and Johnson grass (*Sorghum halepense*).

Valley Oak Woodland Valley oak woodland is uncommon in the potential Sacramento River habitat restoration areas and only occurs at the Anderson River Park site and a small portion of the Tobiasson Island site. This habitat occurs above the active floodplain of the Sacramento River and is characterized by a moderate overstory of valley oak (*Quercus lobata*) with occasional interior live oak (*Quercus wislizenii*), foothill pine (*Pinus sabiniana*), narrowleaf willow, shining willow, Fremont cottonwood, Oregon ash, and tree of heaven (*Ailanthus altissima*). Dominant understory vegetation includes western redbud (*Cercis occidentalis*), California coffee berry (*Frangula californica*), mugwort, winter vetch (*Vicia villosa*), Santa Barbara sedge, ripgut grass, common ragweed (*Ambrosia artemisiifolia*), and Bermuda grass (*Cynodon dactylon*).

Lower Sacramento River and Delta

The roughly 300 miles of the Sacramento River can be subdivided into distinct reaches. The reaches in the lower Sacramento River and Delta portion of the extended study area are discussed separately below because of differences in morphology, riparian vegetation, and habitat functions.

Sacramento River from Red Bluff Pumping Plant to the Delta Most habitat types and many of the wildlife species found in the upper Sacramento River portion of the primary study area have the potential to occur in the Central Valley portion of the extended study area, with additional species occurring in upland and foothill areas. The segment of the extended study area between Red Bluff Pumping Plant and the Delta includes a diverse array of wildlife habitats – floodplains, basins, terraces, active and remnant channels, and oxbow sloughs. The variety and availability of habitats along the middle Sacramento River support a wide range of wildlife species: a variety of resident and migratory waterfowl, raptors, and songbirds, plus a variety of mammals, amphibians, and reptiles that inhabit both aquatic and upland habitats.

Sacramento–San Joaquin River Delta Delta wetlands are considered to be among the most productive wildlife habitats in California. These wetlands consist of permanent saline, brackish, and freshwater marshes; seasonal freshwater wetlands; open water; tidal and nontidal marshes, and emergent wetlands; and seasonally flooded agricultural cropland, such as rice fields (CALFED 2000a). (See the *Wildlife Resources Technical Report* for a discussion of the plant and wildlife species typical of Delta wetlands.)

San Joaquin River Basin to the Delta Most habitat types and many of the wildlife species described above for the Sacramento River corridor have the potential to occur in the Central Valley portion of the extended study area, with additional species occurring in upland and foothill areas. The current wildlife habitat value of this area is somewhat limited by the predominance of agricultural lands, which support a relatively low diversity of wildlife species. However, the orchards, row and field crops, and fallow fields can be used by a number of common species, and fallow fields and some crops (e.g., wheat and barley) can support a variety of small mammals and provide high-quality foraging habitat for many species of raptors. More importantly, remnant native vegetation patches are likely to support a high diversity of wildlife species.

CVP/SWP Service Areas

The CVP and SWP service areas contain a large diversity of both lowland and upland habitats and species, although agricultural and urban growth has reduced the area and connectivity of important habitats that are critical to sustaining a wide variety of unique plants and animals (CALFED 2000a). The agricultural land and urban development that dominate the CVP and SWP service areas, respectively, can support many wildlife species, most of which are highly adapted to these disturbed environments.

13.1.2 Special-Status Species

Special-status species addressed in this section include animals that are legally protected or are otherwise considered sensitive by Federal, State, or local resource conservation agencies and organizations. Specifically, these include species that are Federally listed and/or State-listed as rare, threatened, or endangered; those considered as candidates or proposed for listing as threatened or endangered; species identified by CDFW as fully protected or species of special concern; species identified by USFS as sensitive, or endemic; species identified by the U.S. Department of the Interior, Bureau of Land Management (BLM) as sensitive; species designated by the *Northwest Forest Plan* (NWFP) as survey and manage (S&M); other animals protected by the California Fish and Game Code; and those designated as Multi-Species Conservation Strategy (MSCS) covered species by the CALFED Bay-Delta Program (CALFED).

Shasta Lake and Vicinity

For the purposes of this evaluation, wildlife species of concern include species that are any of the following:

- Designated as threatened or endangered by the State or Federal government
- Proposed or petitioned for Federal listing as threatened or endangered
- State or Federal candidates for listing as threatened or endangered
- Identified by CDFW as a species of special concern
- Considered sensitive or endemic by USFS
- Considered sensitive by BLM
- Considered S&M species by NWFP
- Designated as MSCS-covered species by CALFED

Special-status wildlife species with the potential to occur in the Shasta Lake and vicinity portion of the primary study area were determined using several database searches; review of USFWS and CDFW special-status species lists for Shasta County; review of the CALFED MSCS list; review of other appropriate literature; discussions with BLM, CDFW, DWR, USFS, and USFWS personnel; and professional experience in the area. All special-status wildlife species potentially occurring in the Shasta Lake and vicinity portion of the primary study area are discussed in Attachment 1 of the *Wildlife Resources Technical Report*, which provides a general comparison of habitat requirements for each species and the general habitats in the primary study area above Shasta Dam. For those special-status species for which generally suitable habitat was determined to be present, results from the various vegetation habitat mapping and wildlife surveys conducted in the area by Reclamation since 2002 were used to determine the likelihood of their presence in the primary study area above Shasta Dam (Table 13-4).

The S&M species include all species included in the January 2001 *Record of Decision and Standards and Guidelines for Amendments to the Survey and Manage, Protection Buffer, and Other Mitigation Measures Standards and Guidelines* (U.S. Department of Agriculture and U.S. Department of the Interior 2001) (2001 S&M Record of Decision [ROD]) The current S&M species list is from the 2001 S&M ROD and includes species listed in the 2001 S&M ROD *Survey and Manage Standards and Guidelines and Category Assignment* (BLM December 2013). For the purposes of this evaluation, S&M species of concern include taxa that are designated as Category A and C by the current category assignment. These categories include taxa that require what are known as pre-disturbance (i.e., pre-project) surveys.

The CNDDB was reviewed for records of special-status plant species in or near the Shasta Lake and vicinity portion of the primary study area. The CNDDB is a database consisting of historical observations of special-status plant species, wildlife species, and natural communities. The CNDDB is limited to reported sightings and is not a comprehensive list of special-status species that could occur in a particular area.

Table 13-4. Wildlife Species of Concern in the Shasta Lake and Vicinity Portion of the Primary Study Area

Common Name	Scientific Name	Status[1]	Potential for Occurrence
Western bumble bee	*Bombus occidentalis*	USFS S	Various habitats with abundant flowering vegetation from spring through fall.
Church's sideband	*Monadenis churchi*	S&M	Potentially occurring in mixed conifer and conifer/woodland habitats. Many known occurrences in the Shasta Lake and vicinity portion of the study area.
Shasta sideband	*Monadenia troglodytes troglodytes*	FP, USFS S, S&M, MSCS m	Endemic to Shasta County. Potentially occurring in mixed conifer and woodland habitats, especially near limestone. Species occurs in limestone on the McCloud Arm.
Wintu sideband	*Monadenia troglodytes wintu*	FP, USFS S, S&M	Endemic to Shasta County. Potentially occurring in mixed conifer and woodland habitats, especially near limestone. Known to occur between the Pit and Squaw Creek arms and at Mountain Gate.
Oregon shoulderband	*Helminthoglypta hertlenii*	S&M	Potentially occurring in mixed conifer and conifer/woodland habitats. Many known occurrences in the Shasta Lake and vicinity portion of the study area.
Shasta chaparral	*Trilobopsis roperi*	FP, USFS S, S&M	Endemic to Shasta County. Potentially occurring in mixed conifer and conifer/woodland habitats. Known occurrences in the Shasta Lake and vicinity portion of the study area.
Shasta hesperian	*Vespericola shasta*	FP, USFS S, S&M	Endemic to the southeastern Klamath Mountains. Potentially occurring in mixed conifer and conifer/woodland habitats (riparian and/or riverine habitats). Known occurrences in the Shasta Lake and vicinity portion of the study area.
Shasta salamander	*Hydromantes shastae*	CT, USFS S, S&M, MSCS m, BLMS	Only known from the southeastern Klamath Mountains. Potentially occurring in mixed conifer, woodland, and chaparral habitats, especially near limestone. Known occurrences in the Shasta Lake and vicinity portion of the study area.
Tailed frog	*Ascaphus truei*	CSC	Potentially occurring in stream habitats in the Shasta Lake and vicinity portion of the study area. Known occurrences in the McCloud Arm and the upper Sacramento Arm tributaries outside the study area boundaries (CDFG 2003).

Table 13-4. Wildlife Species of Concern in the Shasta Lake and Vicinity Portion of the Primary Study Area (contd.)

Common Name	Scientific Name	Status[1]	Potential for Occurrence
California red-legged frog	*Rana draytonii*	FT, CSC, MSCS m	Requires aquatic habitat for breeding; also uses a variety of other habitat types, including riparian and upland areas. The Shasta Lake and vicinity portion of the study area is outside the current species range. A USFWS habitat assessment is in preparation to determine habitat suitability.
Foothill yellow-legged frog	*Rana boylii*	CSC, USFS S, MSCS m, BLMS	Potentially occurring in stream habitats. Known occurrences scattered throughout the Shasta Lake and vicinity portion of the primary study area.
Northwestern pond turtle	*Actinemys marmorata*	CSC, USFS S, MSCS m	Potentially occurring in stream or other wetland habitats. Adjacent upland habitats are potential nesting areas. Known occurrences scattered throughout the Shasta Lake and vicinity portion of the primary study area.
Great blue heron	*Ardea herodias*	MSCS m	Known to breed in nearshore wooded habitat in the Turntable Bay area of Shasta Lake.
Cooper's hawk	*Accipiter cooperi*	MSCS m	Potentially occurring in mixed conifer and conifer/woodland habitats.
Northern goshawk	*Accipiter gentilis*	CSC, USFS S, BLMS	Potentially occurring in mixed conifer habitats. Known to occur in the upper McCloud Arm.
Bald eagle	*Haliaeetus leucocephalus*	FD, FB, CE, CP, USFS S, MSCS m, BLMS	Occur in riverine and lacustrine habitats. Common at Shasta Lake, and a substantial number of nests occur in the Shasta Lake and vicinity portion of the primary study area and vicinity. Shasta Lake has the highest density of breeding bald eagles in the continental United States.
Osprey	*Pandion haliaetus*	MSCS m	Occur in riverine and lacustrine habitats. Common at Shasta Lake, and many known nests occur in the Shasta Lake and vicinity portion of the primary study area and vicinity.
American peregrine falcon	*Falco peregrinus anatum*	FD, CD, CP, MSCS m	Potentially occurring in mixed conifer and conifer/woodland habitats. Nesting sites in the study area unlikely due to lack of suitable eyrie sites; however, potential eyrie sites occur adjacent to the Shasta Lake and vicinity portion of the primary study area. A historical nest site occurs in the cliffs near Shasta Caverns and a "new" nest site is believed to occur in cliffs along the Sacramento Arm of Shasta Lake. Another nest site is located south of Shasta Lake at Gray Rocks, near Mountain Gate.
Long-eared owl	*Asio otus*	CSC, MSCS m	Potentially occurring in coniferous forest habitats.

Table 13-4. Wildlife Species of Concern in the Shasta Lake and Vicinity Portion of the Primary Study Area (contd.)

Common Name	Scientific Name	Status[1]	Potential for Occurrence
Northern spotted owl	*Strix occidentalis caurina*	FT, MSCS m	Potentially occurring in coniferous forest habitats. The species has been recorded within 0.5 mile of the study area along the Squaw Creek Arm. Potential dispersal habitat occurs in the Shasta Lake and vicinity portion of the primary study area. No designated critical habitat occurs in the Shasta Lake and vicinity portion of the primary study area.
Vaux's swift	*Chaetura vauxi*	CSC	Potentially occurring in coniferous forest and conifer/woodland habitats. Known to occur in the Shasta Lake and vicinity portion of the study area.
Willow flycatcher	*Empidonax traillii*	CE, USFS S, MSCS r	Uncommon migrant in riparian habitat; unlikely to nest in the Shasta Lake and vicinity portion of the primary study area.
Purple martin	*Progne subis*	CSC	Potentially occurring in conifer, woodland, and riparian habitats. Foraging habitat occurs throughout Shasta Lake and vicinity portion of the primary study area. Nests along the Pit River Arm. Shasta Lake is one of the few known breeding sites in interior northern California.
Yellow warbler	*Dendroica petechia brewsteri*	CSC, MSCS r	Potentially occurring in riparian habitats. Known occurrences in and near the Shasta Lake and vicinity portion of the primary study area.
Yellow-breasted chat	*Icteria virens*	CSC, MSCS m	Potentially occurring in riparian habitats. Known occurrences in and near the Shasta Lake and vicinity portion of the primary study area.
Pallid bat	*Antrozous pallidus*	CSC, USFS S, BLMS	Potentially occurring in mixed conifer and conifer/woodland habitat throughout the study area.
Townsend's big-eared bat	*Plecotus townsendii*	CSC, USFS S	Potentially occurring in mixed conifer and conifer/woodland habitat throughout the study area. Known occurrence from a cave on the Backbone Arm in the Shasta Lake and vicinity portion of the primary study area.
Spotted bat	*Euderma maculatum*	CSC, BLMS	Potentially occurring in mixed conifer and conifer/woodland habitat throughout the study area. Species has been recorded on Squaw Creek within approximately 6 miles of the Shasta Lake and vicinity portion of the primary study area.
Western red bat	*Lasiurus blossevillii*	CSC	Potentially occurring in mixed conifer and conifer/woodland habitat throughout the Shasta Lake and vicinity portion of the primary study area.
Long-eared myotis	*Myotis evotis*	BLMS	Potentially occurring in a wide variety of forest habitats throughout the study area.
Yuma myotis	*Myotis yumanensis*	BLMS	Potentially occurring in a wide variety of forest habitats throughout the study area.

Table 13-4. Wildlife Species of Concern in the Shasta Lake and Vicinity Portion of the Primary Study Area (contd.)

Common Name	Scientific Name	Status[1]	Potential for Occurrence
Fringed myotis	*Myotis thysanodes*	USFS S	Potentially occurring in mixed conifer and conifer/woodland habitat throughout the Shasta Lake and vicinity portion of the primary study area.
Western mastiff bat	*Eumops perotis*	CSC, MSCS m (*californicus* subspecies only), BLMS	Potentially occurring in mixed conifer and conifer/woodland habitat throughout the Shasta Lake and vicinity portion of the primary study area.
Ringtail	*Bassariscus astutus*	CP, MSCS m	Potentially occurring in mixed conifer and conifer/woodland habitats. Known occurrences in and near the Shasta Lake and vicinity portion of the primary study area.
American marten	*Martes americana*	USFS S	Potentially occurring in mixed conifer habitats.
Pacific fisher	*Martes pennanti*	FC, CSC, USFS S, BLMS	Potentially occurring in mixed conifer and conifer/woodland habitats. Known occurrences in and near the Shasta Lake and vicinity portion of the primary study area.

Note:
[1]Status Definitions

Key:
BLMS = U.S. Department of the Interior, Bureau of Land Management sensitive
CD= California delisted
CE = California endangered
CP = California fully protected
CSC = California species of special concern
CT = California (State) listed as threatened
FB = Federal Bald and Golden Eagle Protection Act
FC = Federal candidate for listing
FD = Federally delisted
FP = Federally petitioned for listing
FPD = Proposed for Federal delisting
FT = Federally listed as threatened
m = Maintain. Ensure that any adverse effects on the species that could be associated with implementation of CALFED Bay-Delta Program actions will be fully offset through implementation of actions beneficial to the species.
MSCS = Multi-Species Conservation Strategy covered species
r = Contribute to recovery. Implement some of the actions deemed necessary to recover species' populations in the Multi-Species Conservation Strategy focus area.
USFS M = U.S. Forest Service survey and manage species
USFS S = U.S. Forest Service sensitive

Species accounts for special-status wildlife in the Shasta Lake and vicinity portion of the primary study area are described in detail in Attachment 2 of the *Wildlife Resources Technical Report*. Figures 13-5a through 13-5f depict the known locations of special-status wildlife species in the primary study area above Shasta Dam located during various surveys conducted by Reclamation and from USFS records. Figures 13-6a through 13-6f depict the known locations of special-status terrestrial mollusks.

Summary of Wildlife Investigations

Terrestrial Mollusk Surveys (Survey and Manage) Reclamation has conducted three survey efforts for S&M terrestrial mollusk species in the Shasta Lake and vicinity portion of the primary study area. These include protocol-level efforts during 2002 to 2003 and 2005 along selected portions of the Shasta Lake shoreline, surveys conducted in 2010 at the relocation areas. Additionally, many other terrestrial mollusk locations have been found incidentally during numerous other biological survey tasks throughout the Shasta Lake and vicinity portion of the primary study area. Six S&M terrestrial mollusk species have been found to date: Church's sideband (*Monadenia churchi*), Shasta sideband (*Monadenia troglodytes troglodytes*), Wintu sideband (*Monadenia troglodytes wintu),* Oregon shoulderband (*Helminthoglypta hertlenii*), Shasta chaparral (*Trilobopsis roperi*), and Shasta hesperian (*Vespericola shasta*). Church's sideband and Oregon shoulderband were the most commonly occurring terrestrial mollusk species, as they were found at 325 and 220 locations, respectively. Shasta hesperian was found at 69 locations, while Shasta sideband and Shasta chaparral were found at 29 locations each. Wintu sideband was the least commonly occurring terrestrial mollusk species and was found at 2 locations (Figures 13-6a through 13-6f).

Shasta Salamander Surveys Reclamation has conducted three survey efforts for Shasta salamander in the Shasta Lake and vicinity portion of the primary study area. These include survey efforts during 2003 and 2006 to 2007 along selected portions of the Shasta Lake shoreline and surveys performed in 2010 and 2011 at the relocation areas. Additionally, several other Shasta salamander locations have been found incidentally during other biological survey tasks throughout the Shasta Lake and vicinity portion of the primary study area. Collectively, Shasta salamanders have been found at 39 locations during the survey efforts. These findings and other known locations show that this species occurs in all arms of Shasta Lake in both limestone and nonlimestone habitats (Figures 13-5a through 13-5f).

Bald Eagle/Osprey Surveys Reclamation mapped all known bald eagle and osprey nests in the Shasta Lake and vicinity portion of the primary study area in 2007 and 2010. Additional data, including diameter of nest trees, nest tree height, nest height, proximity to the high-water mark, surrounding vegetation, and shoreline erosion rating, were recorded for the bald eagle nests. Twenty-eight bald eagle nests and 54 osprey nests were located. Reclamation continued surveys and coordination with the USFS through 2013 to maintain current bald eagle and osprey nest site locations. Currently, 32 bald eagle and 54 osprey nest sites are known within or near the Shasta Lake and vicinity portion of the primary study area (Figures 13-5a through 13-5f).

Neotropical Migrant Bird Surveys Reclamation conducted a breeding bird survey in the Shasta Lake and vicinity portion of the primary study area in 2007. Additionally, focused surveys for purple martins and an analysis of purple martin habitat at Shasta Lake were conducted. These surveys provided information on use of the Shasta Lake and vicinity portion of the primary study area by breeding birds, including breeding neotropical migrant species. Sixty-seven bird species were detected during these surveys, including 38 neotropical migrant species.

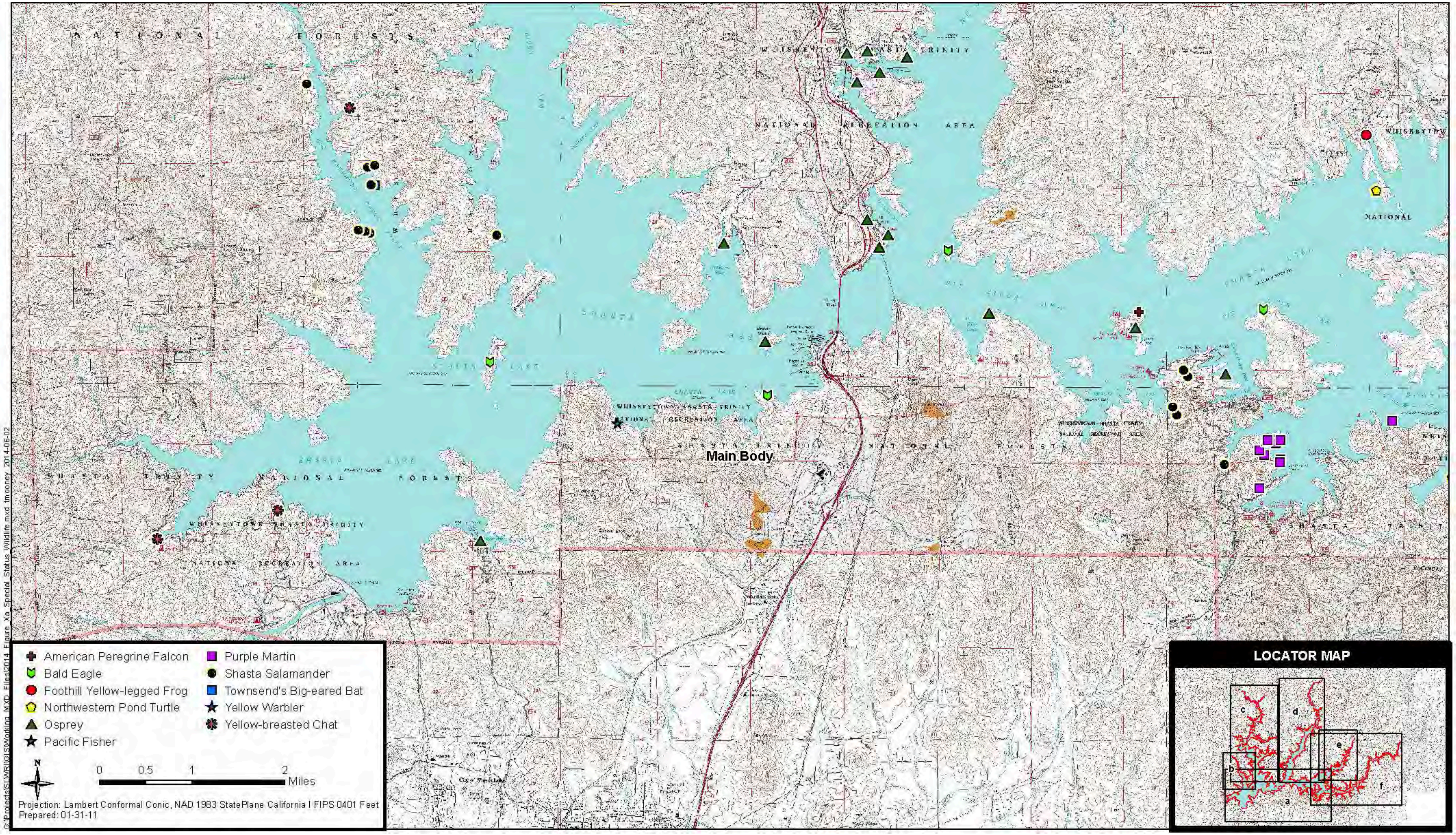


Figure 13-5a. Special-Status Wildlife Occurring in Shasta Lake and Vicinity

This page left blank intentionally.

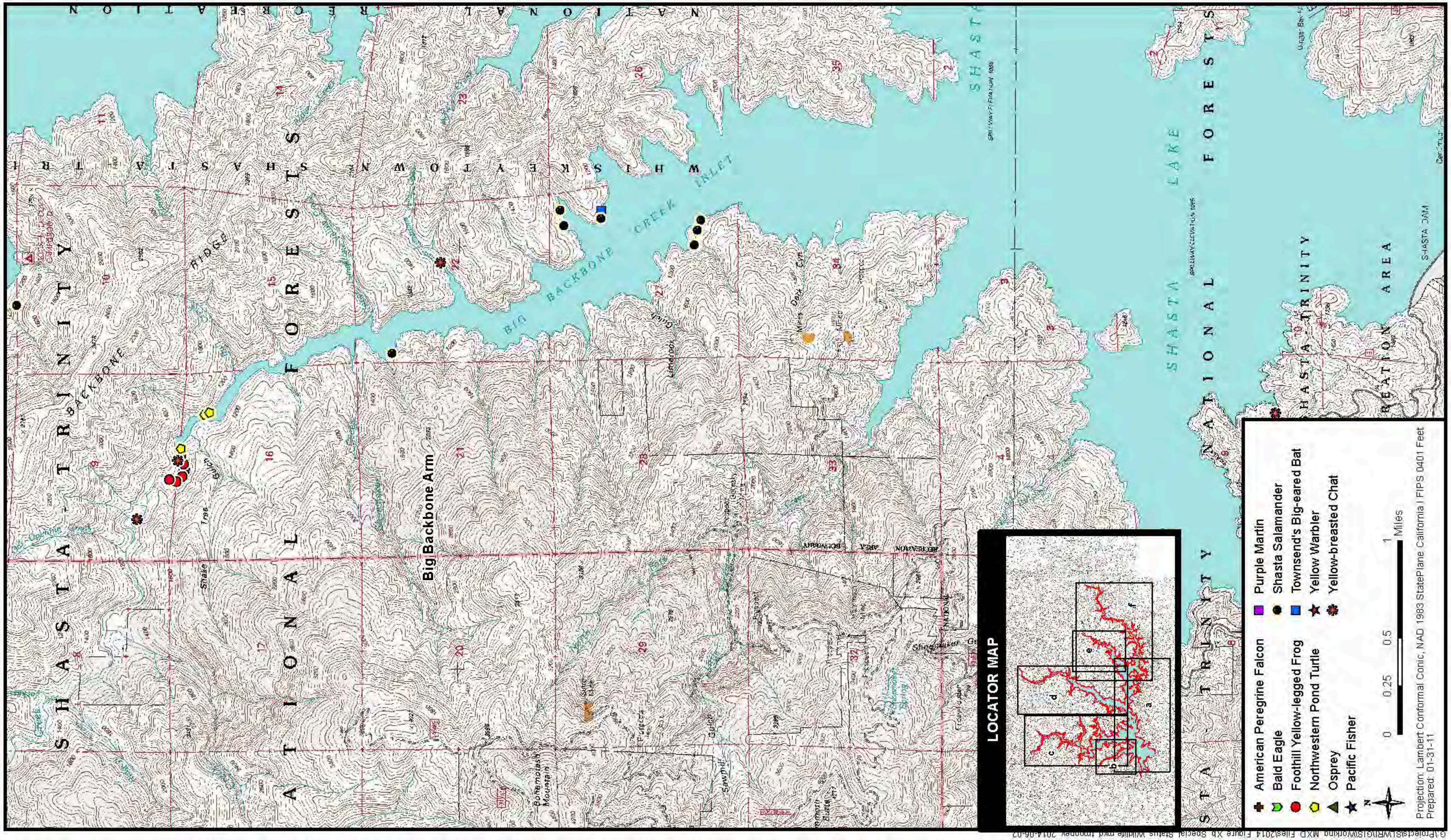


Figure 13-5b. Special-Status Wildlife Occurring in Shasta Lake and Vicinity

This page left blank intentionally.

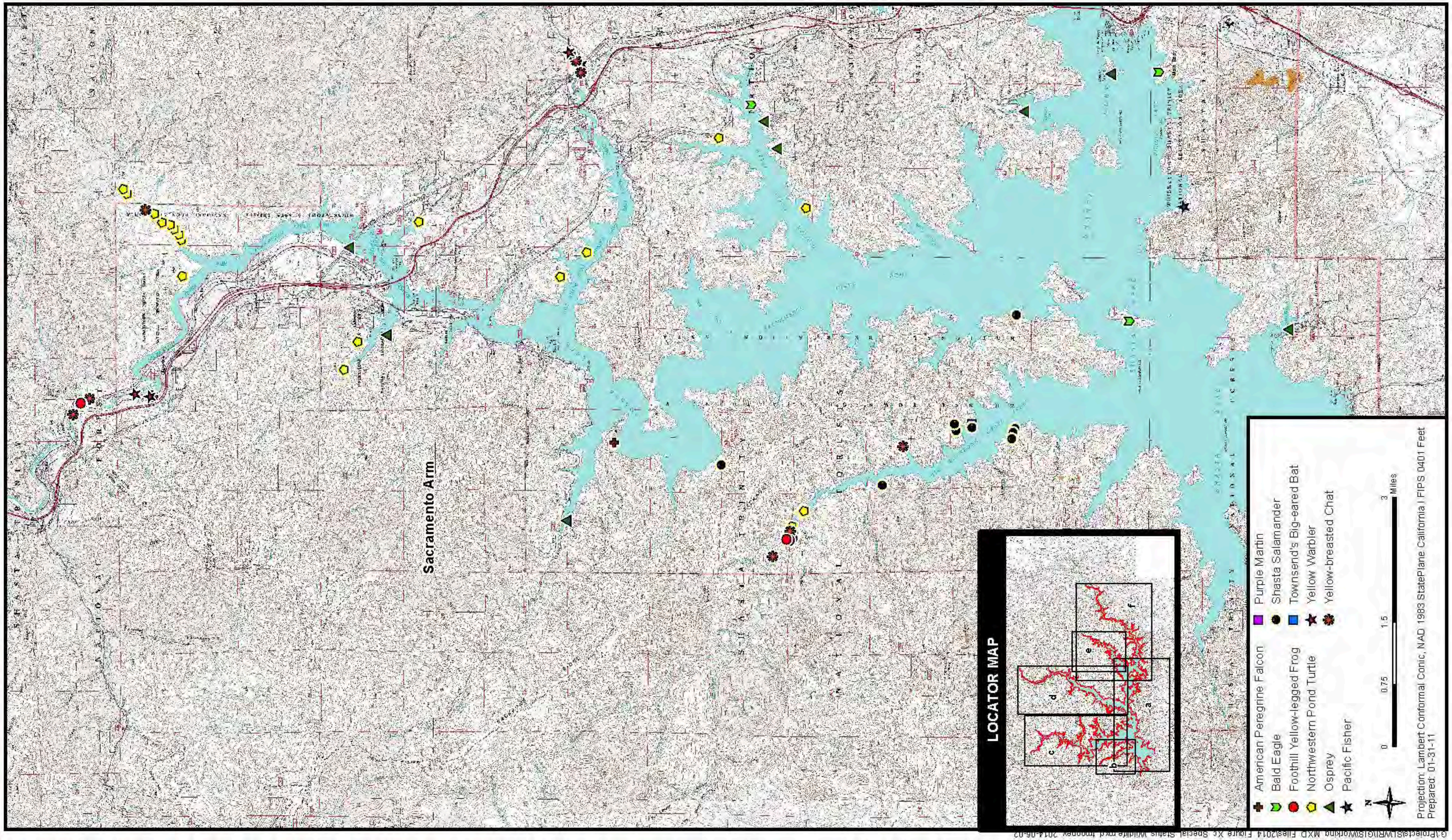


Figure 13-5c. Special-Status Wildlife Occurring in Shasta Lake and Vicinity

This page left blank intentionally.

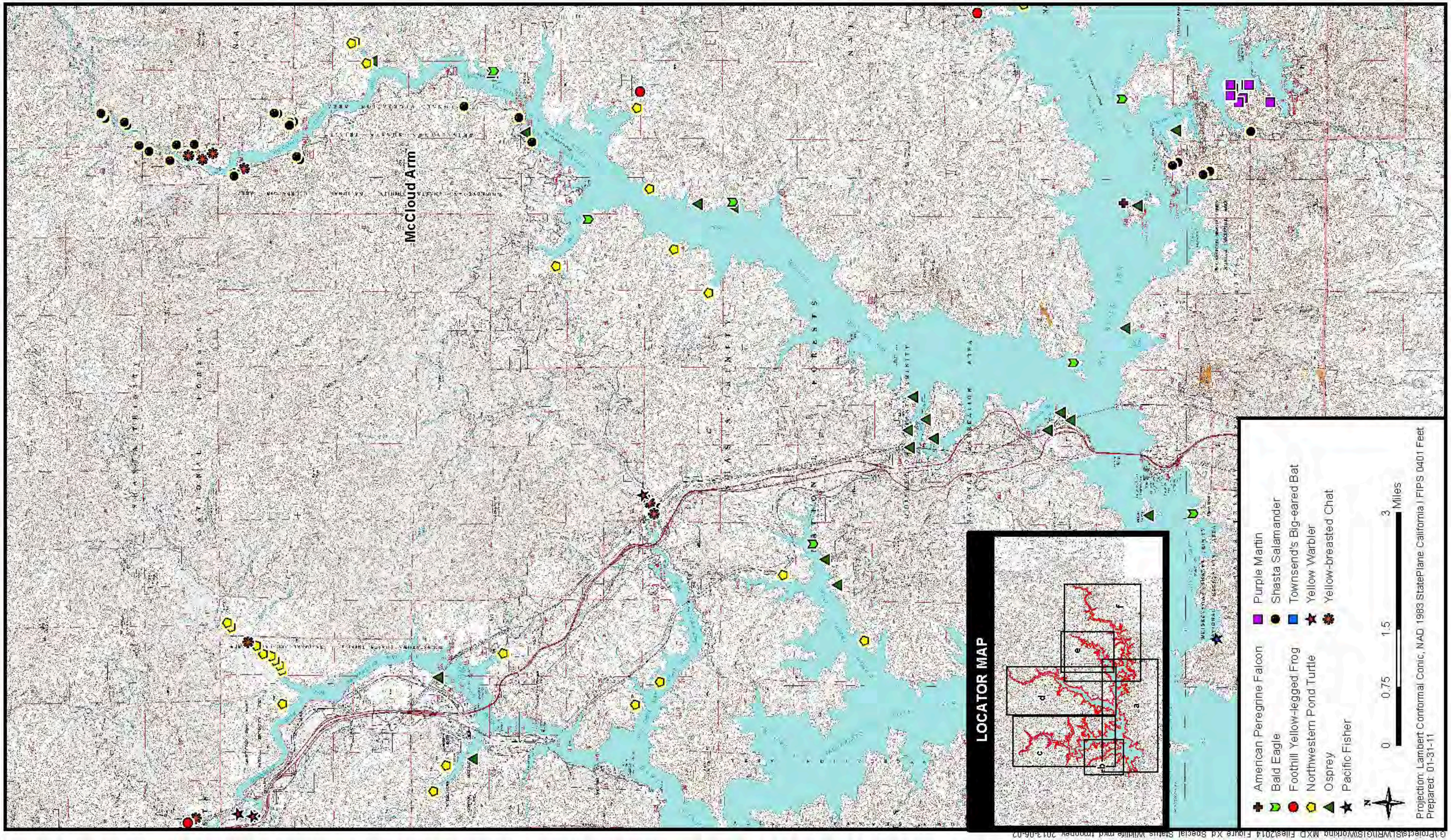


Figure 13-5d. Special-Status Wildlife Occurring in Shasta Lake and Vicinity

This page left blank intentionally.

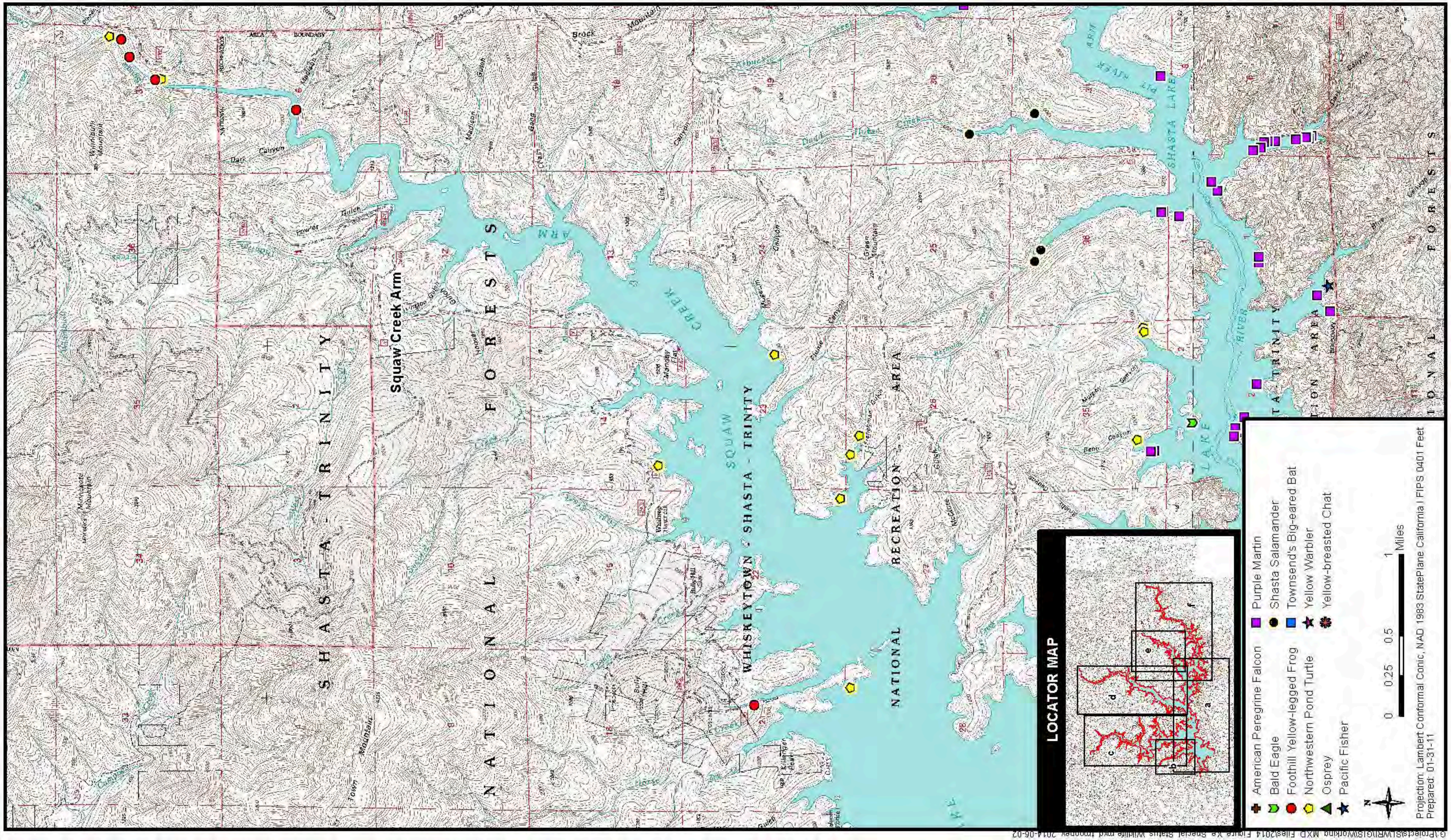


Figure 13-5e. Special-Status Wildlife Occurring in Shasta Lake and Vicinity

This page left blank intentionally.

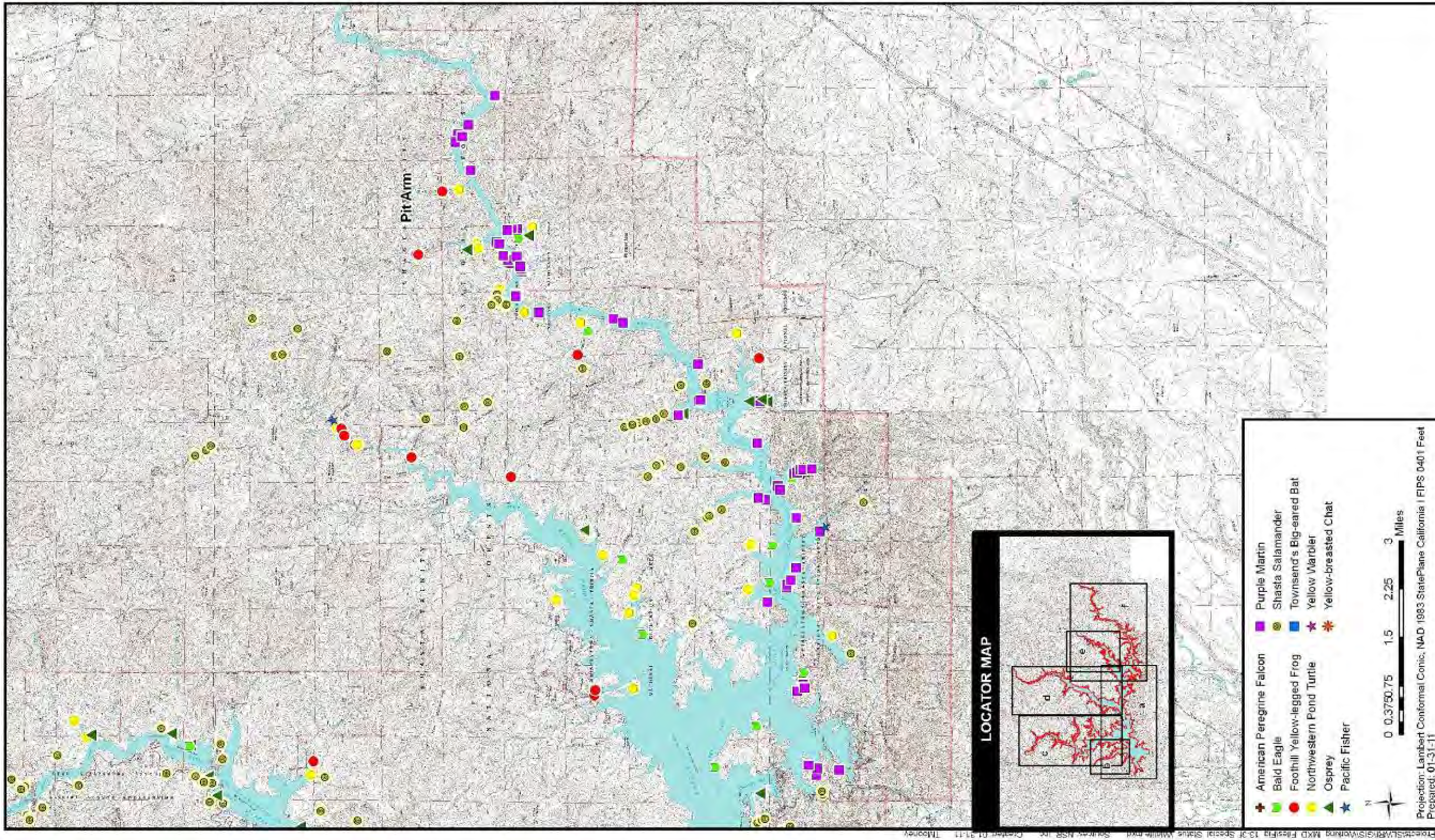


Figure 13-5f. Special-Status Wildlife Occurring in Shasta Lake and Vicinity

This page left blank intentionally.

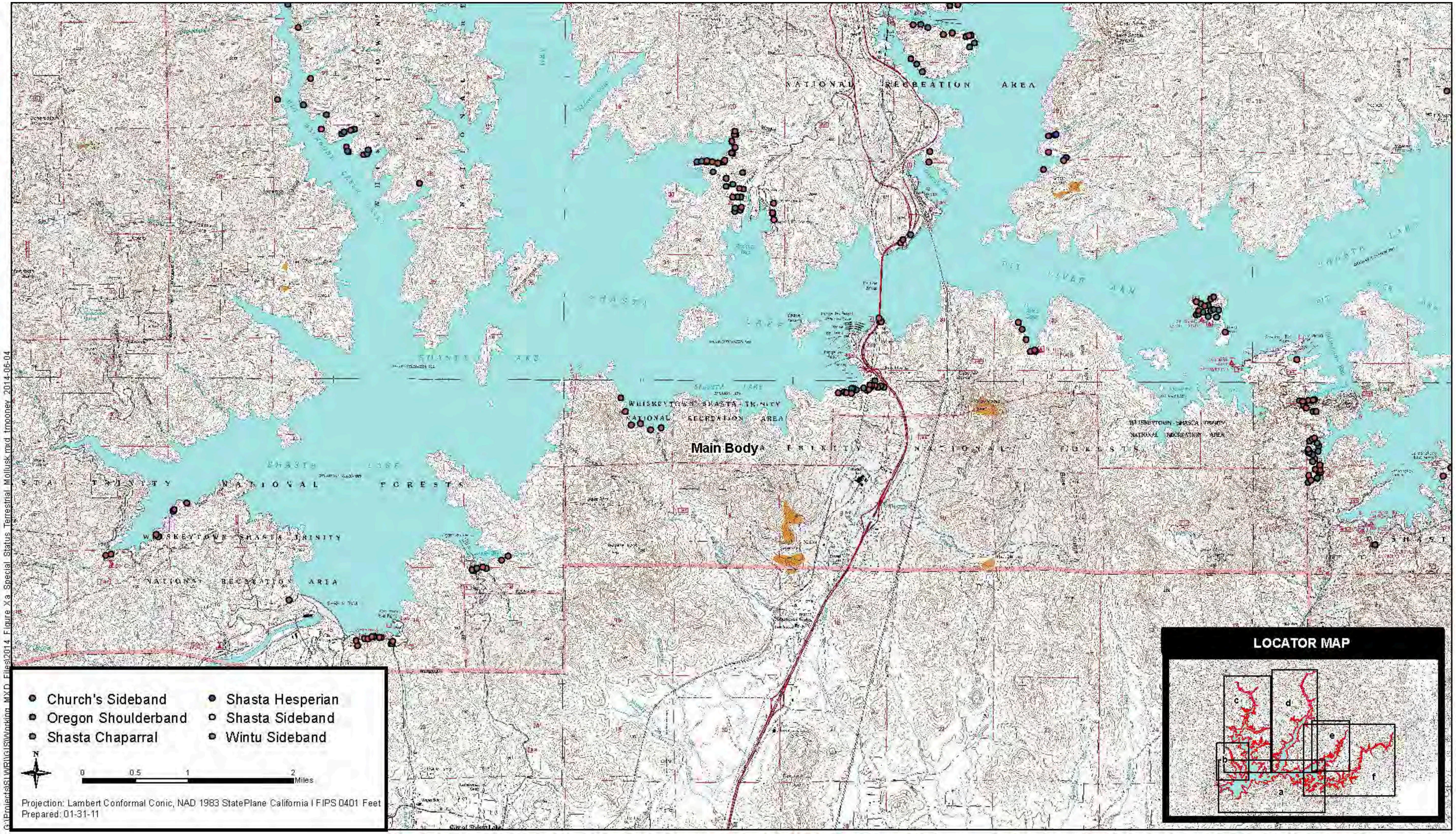


Figure 13-6a. Special-Status Terrestrial Mollusks Occurring in Shasta Lake and Vicinity

This page left blank intentionally.

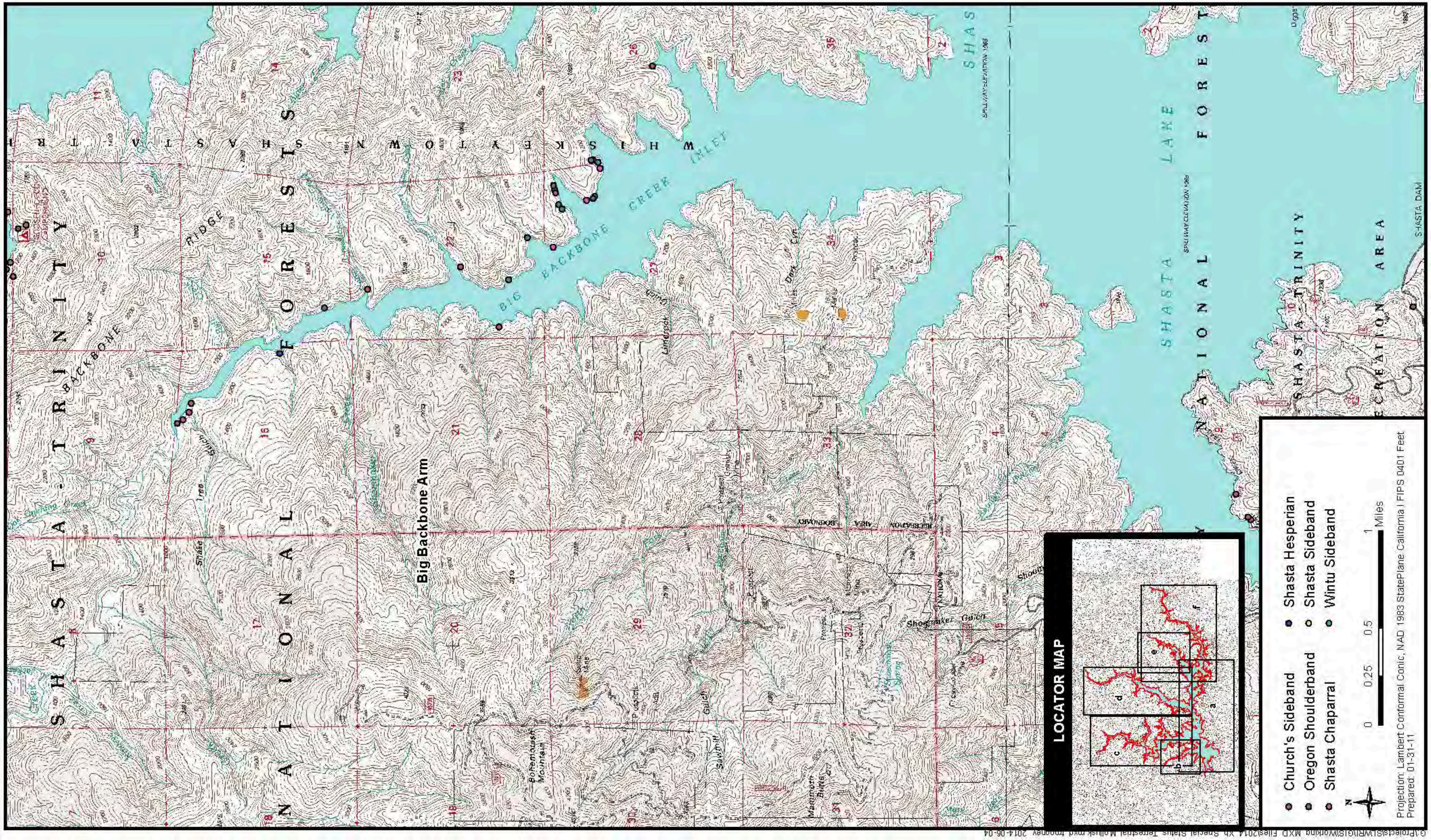


Figure 13-6b. Special-Status Terrestrial Mollusks Occurring in Shasta Lake and Vicinity

This page left blank intentionally.

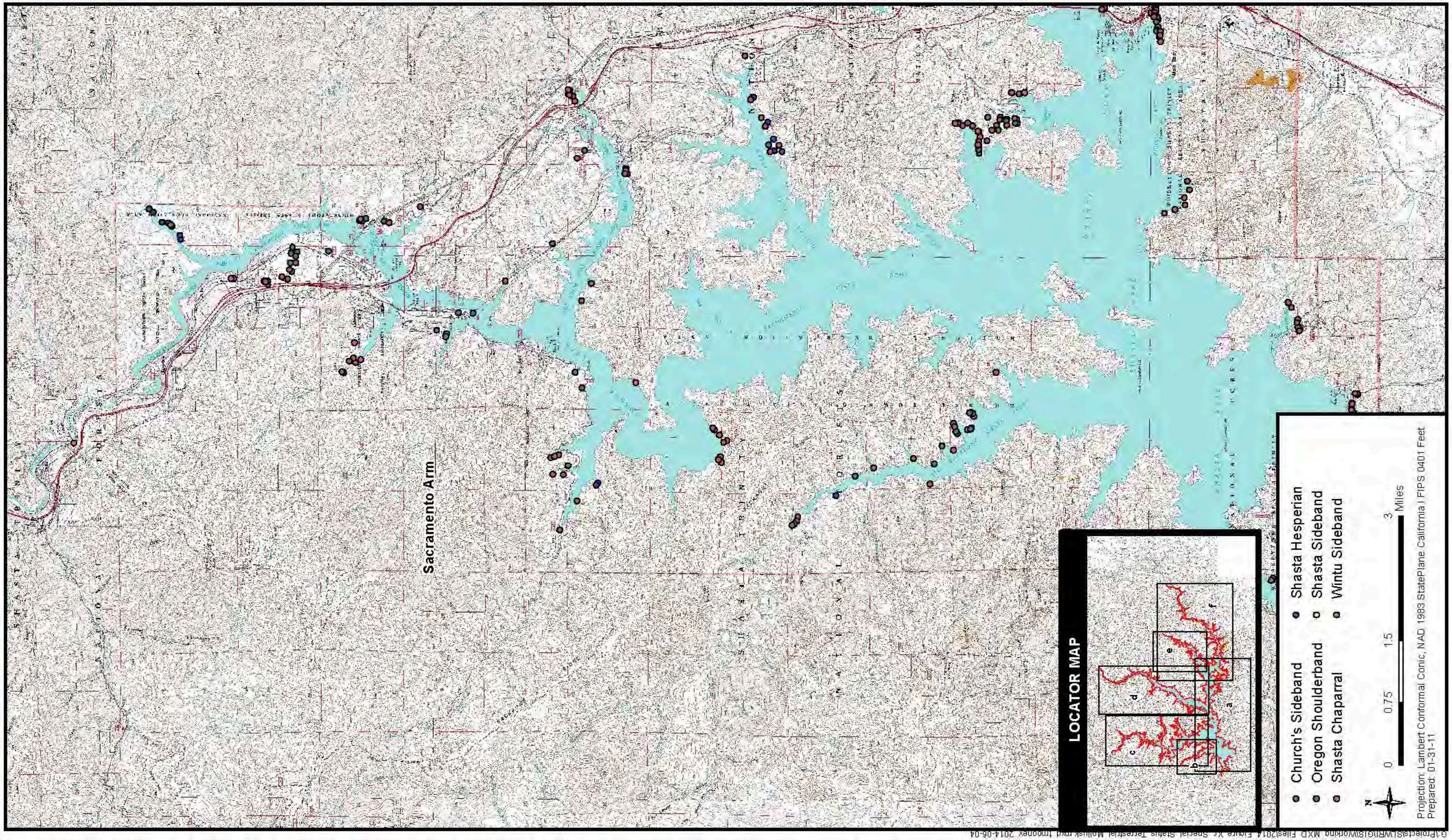


Figure 13-6c. Special-Status Terrestrial Mollusks Occurring in Shasta Lake and Vicinity

This page left blank intentionally.

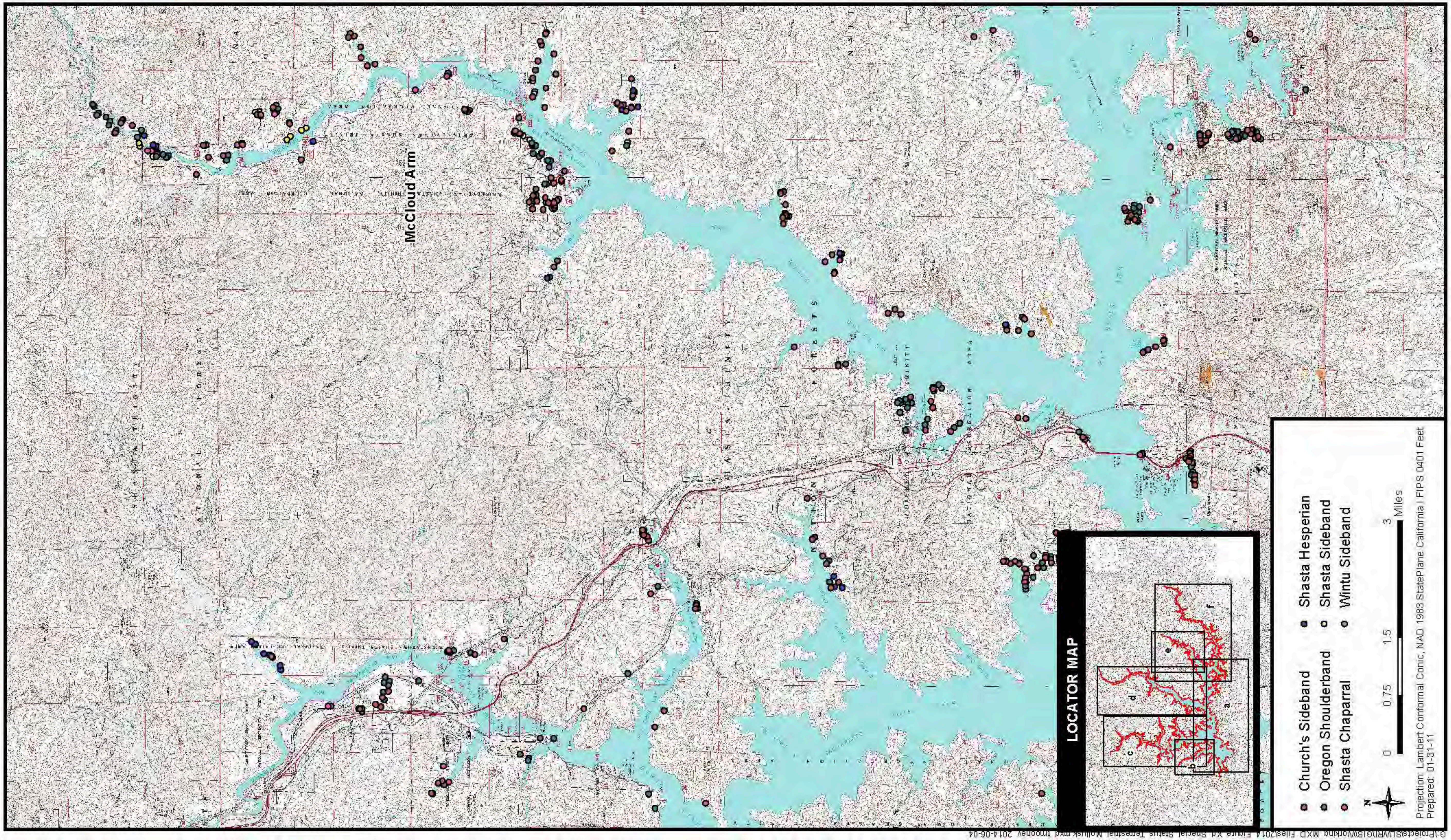


Figure 13-6d. Special-Status Terrestrial Mollusks Occurring in Shasta Lake and Vicinity

This page left blank intentionally.

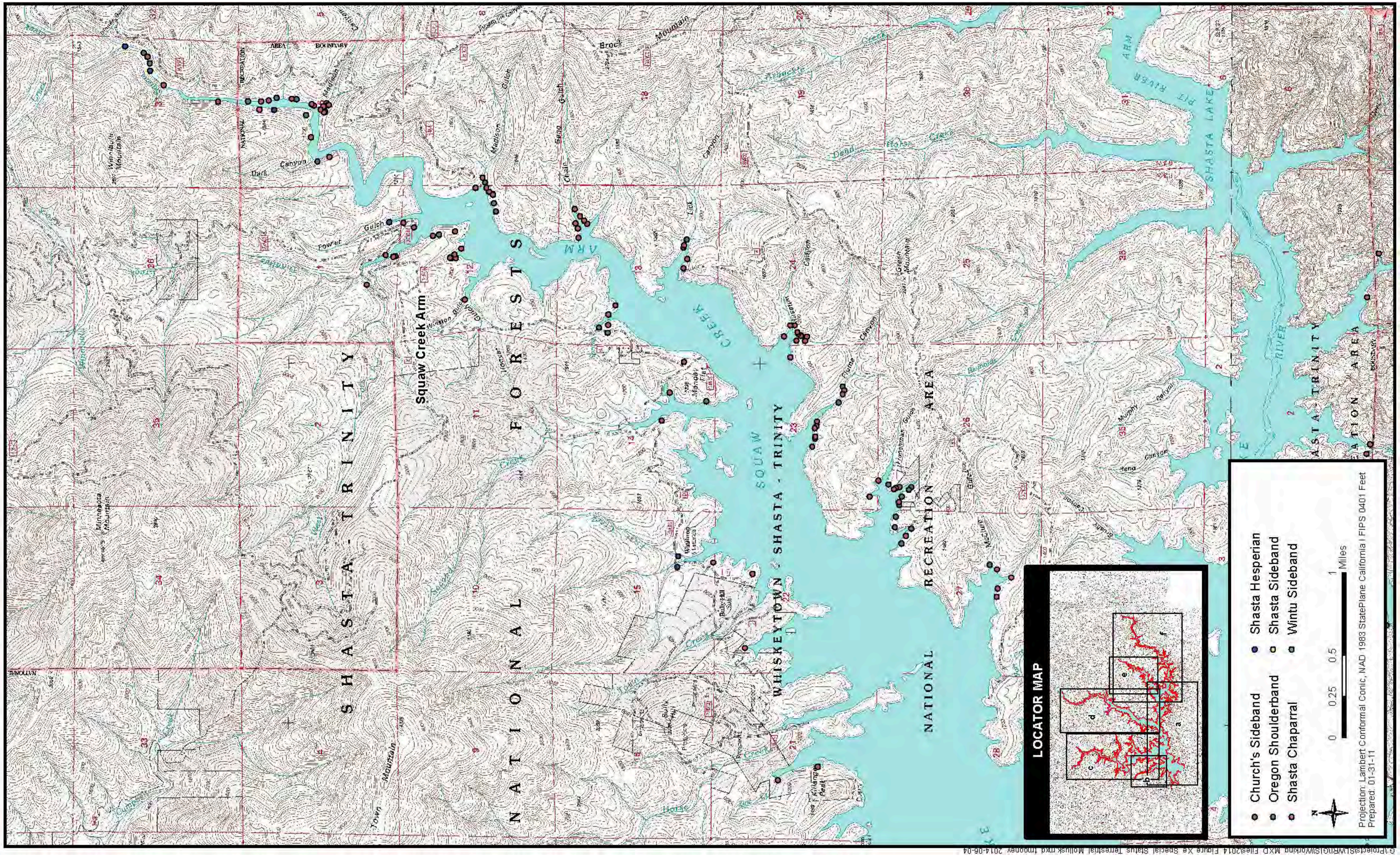


Figure 13-6e. Special-Status Wildlife Occurring in Shasta Lake and Vicinity

This page left blank intentionally.

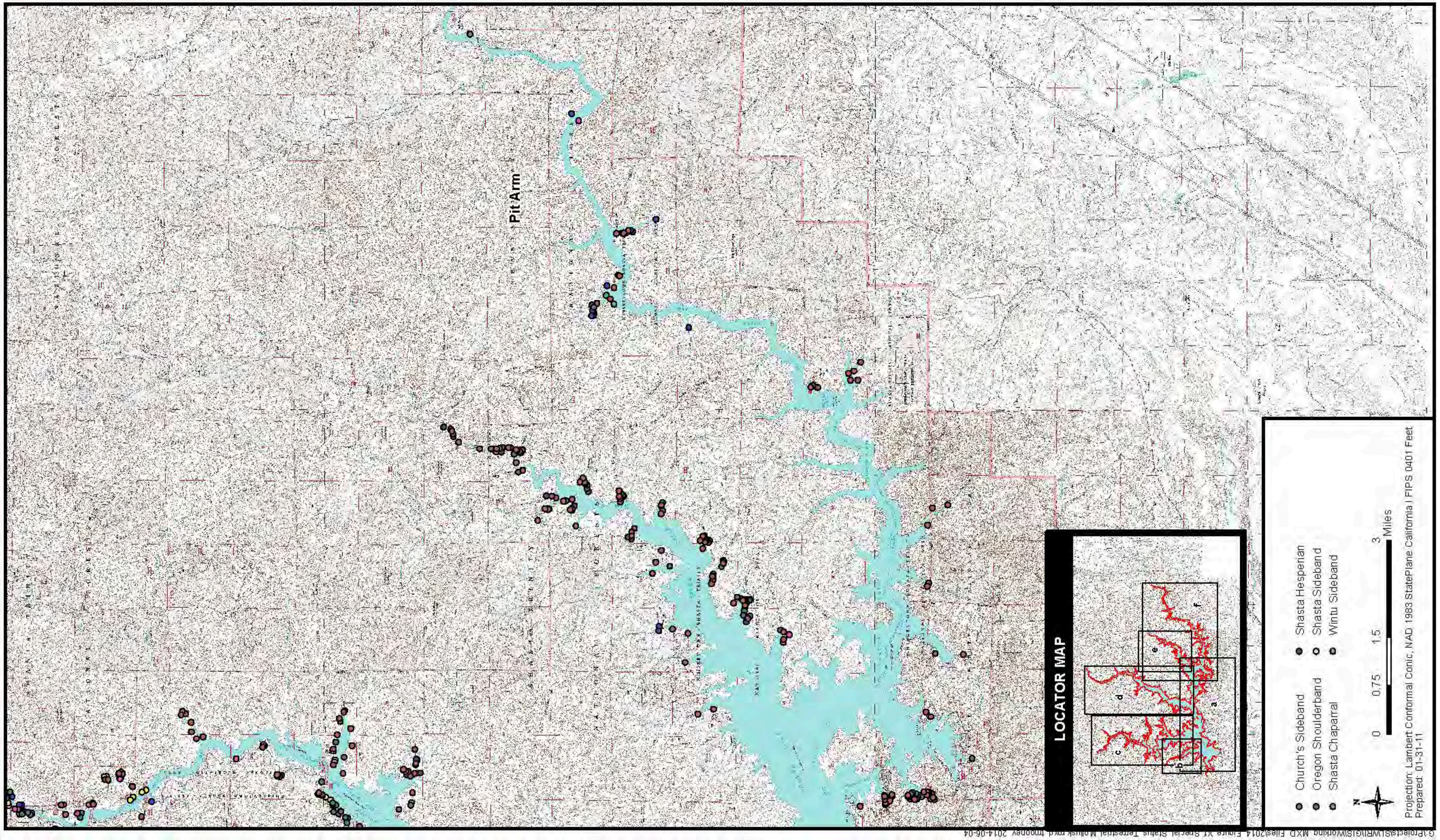


Figure 13-6f. Special-Status Terrestrial Mollusks Occurring in Shasta Lake and Vicinity

This page left blank intentionally.

These surveys also provided a basic understanding of purple martin ecology in the Shasta Lake and vicinity portion of the primary study area. Purple martin monitoring has continued through 2013, providing additional information on species distribution and habitat use (Figures 13-5d through 13-5f). The nesting purple martin population has totaled 18, 21, 24, 28, 42,27, and 17 pairs from 2007 through 2013, respectively. Most nest sites occur in flooded snags located in the reservoir; however, monitoring results show an increase in use of upland nest sites. Limited historical information from purple martin surveys information from 1978 to 2001 showed 14 to 19 nesting pairs at Shasta Lake. During the monitoring period, the nesting purple martin population showed small increases from 2007 through 2010, a large increase in 2011, and then generally returned to 2009 and 2010 levels in 2012. For unknown reasons a marked decrease to 17 pairs occurred in 2013, a population size similar to historic numbers. The 2007 to 2013 monitoring results initially show a stable to increasing population, followed by a decrease and return to more historic levels.

Forest Carnivore Surveys Reclamation conducted surveys for sensitive forest carnivore species (forest carnivores) in the Shasta Lake and vicinity portion of the primary study area during 2003 to 2005. The specific sensitive forest carnivore species (i.e., “target species”) surveyed included the Sierra Nevada red fox (*Vulpes vulpes necator*), American marten (*Martes americana*), Pacific fisher (*Martes pennanti*), and wolverine (*Gulo gulo*). One target forest carnivore species, the Pacific fisher, was detected. Pacific fisher was detected at 13 locations scattered in all areas of the Shasta Lake and vicinity portion of the primary study area, except the McCloud Arm (Figures 13-5a through 13-5f). Forest carnivore surveys conducted during 2007 and 2010 along the McCloud Arm for this project and another unrelated project detected Pacific fisher and found that the species occurs in all areas of the Shasta Lake and vicinity portion of the primary study area. Additionally, the ringtail, a California fully protected species, was detected in all areas of the Shasta Lake and vicinity portion of the primary study area during the forest carnivore surveys.

The Pacific fisher survey results provide additional information on habitat use and distribution of the species in Northern California. The survey findings represent the southeastern-most Pacific fisher occurrences in the Klamath region. Additionally, these findings show Pacific fishers in areas generally (previously) not considered habitat in California, including open second-growth conifer, hardwood–conifer, and hardwood habitats that have extensive chaparral components. Pacific fishers were also detected in forest habitats that were barren or semi-barren 50 to 60 years ago because of historical copper mining and smelting activities, and near commercial, rural residential, and industrial development areas.

California Red-Legged Frog Assessment Reclamation conducted a California red-legged frog habitat assessment in the Shasta Lake and vicinity portion of the primary study area in 2010 and 2012. In consultation with the USFWS, an assessment area was developed and field surveys of aquatic habitats were conducted in accordance with *Revised Guidance on Site Assessments and Field Surveys for the California Red-Legged Frog* (USFWS 2005a). The results suggest only one feature may represent potential California red-legged frog breeding habitat. A California red-legged frog habitat assessment report was submitted to the USFWS.

Upper Sacramento River (Shasta Dam to Red Bluff)

The following section provides a detailed discussion of wildlife species of concern specific to the potential Sacramento River downstream habitat restorations areas, as well as the wildlife species of concern known to occur or with potential to occur along the Sacramento River throughout the rest of the primary study area.

A list of special-status wildlife species with the potential to occur in the primary study area from Shasta Dam to the Red Bluff Pumping Plant (Table 13-5) was compiled based on habitat suitability and known occurrences within the area covered in the Shasta Dam, Redding, Enterprise, Cottonwood, Balls Ferry, Bend, and Red Bluff East U.S. Geological Survey 7.5-minute quadrangle maps (CNDDB 2012; USFWS 2011). This list also includes species that are identified by USFS as sensitive, or endemic; identified by BLM as sensitive; designated by the NWFP as S&M; or designated as MSCS covered species. See the *Wildlife Resources Technical Report* for a description of the life history of special-status wildlife species known or likely to occur in the area and figures depicting the recorded locations of special-status species.

Table 13-5. Special-Status Wildlife Species Known or with Potential to Occur in the Primary Study Area, Along the Sacramento River from Shasta Dam to Red Bluff Pumping Plant

Common Name	Scientific Name	Status[1]	Potential for Occurrence
Invertebrates			
Conservancy fairy shrimp	*Branchinecta conservatio*	FE, MSCS	Unlikely to occur. No suitable habitat is present along the river corridor.
Valley elderberry longhorn beetle	*Desmocerus californicus dimorphus*	FPD, FT, MSCS	Known to occur. Elderberry shrubs are present within the riparian woodland community along the Sacramento River.
Vernal pool tadpole shrimp Critical Habitat	*Lepidurus packardi*	FE, MSCS	Unlikely to occur. No suitable habitat is present along the river corridor. Critical habitat does not occur within the river corridor.
Vernal pool fairy shrimp Critical Habitat	*Branchinecta lynchi*	FT, MSCS	Unlikely to occur. No suitable habitat is present along the river corridor. Critical habitat does not occur within the river corridor.
Amphibians			
Shasta salamander	*Hydromantes shastae*	CT, BLM S, USFS S	Unlikely to occur. Suitable habitat generally is not found within the river corridor downstream from Shasta Dam.
California red-legged frog	*Rana aurora draytonii*	FT, CSC, MSCS	Could occur along the Sacramento River if suitable habitat is present
Foothill yellow-legged frog	*Rana boylii*	CSC, USFS S, MSCS	Could occur along the Sacramento River if suitable habitat is present
Western spadefoot toad	*Spea hammondii*	CSC, MSCS	Unlikely to occur. No suitable habitat is present along the Sacramento River corridor.
Reptiles			
Giant garter snake	*Thamnophis gigas*	FT, CT, MSCS	Unlikely to occur in the primary study area; however, known to occur in the extended study area.
Western pond turtle	*Actinemys (Clemmys) marmorata*	CSC, USFS S, MSCS	Known to occur. Suitable habitat is present in the primary study area.
Birds			
Cackling goose *(Aleutian Canada goose)*	*Branta hutchinsii leucopareia*	FD, MSCS	Unlikely to occur within the banks of the Sacramento River where flows could be altered.
American peregrine falcon *(nesting)*	*Falco peregrinus anatum*	CP, USFS S, MSCS	Unlikely to nest in this portion of the study area; however, may forage in areas of open water with large concentrations of waterbirds.
Bald eagle (nesting and wintering)	*Haliaeetus leucocephalus*	FD, CE, CP, USFS S, MSCS	Known to occur along the Sacramento River in the primary study area.
Bank swallow (nesting)	*Riparia riparia*	CT, MSCS	Known to occur along the Sacramento River in the primary study area.
Black-crowned night heron (rookery)	*Nycticorax nycticorax*	BLM S, MSCS	Could nest in trees adjacent to the Sacramento River.

Table 13-5. Special-Status Wildlife Species Known or with Potential to Occur in the Primary Study Area, Along the Sacramento River from Shasta Dam to Red Bluff Pumping Plant (contd.)

Common Name	Scientific Name	Status[1]	Potential for Occurrence
California gull (nesting colony)	*Larus californicus*	MSCS	Not within breeding range. Could occur in the study area during winter or migration.
Cooper's hawk (nesting)	*Accipiter cooperii*	MSCS	Could occur. Suitable nesting and foraging habitat is present in the primary study area.
Double-crested cormorant (rookery)	*Phalacrocorax auritus*	MSCS	Could nest in trees adjacent to the Sacramento River.
Golden eagle	*Aquila chrysaetos*	CP, BLM S, MSCS	No suitable nesting habitat along the Sacramento River. Unlikely to forage along the river corridor.
Great blue heron (rookery)	*Ardea herodius*	MSCS	Could nest in trees adjacent to the Sacramento River.
Great egret (rookery)	*Casmerodius albus*	MSCS	Could nest in trees adjacent to the Sacramento River.
Greater sandhill crane (nesting and wintering)	*Grus canadensis tabida*	CT, CP, MSCS	Unlikely to breed in the primary study area. Unlikely to use the Sacramento River corridor during winter or migration.
Least bittern (nesting)	*Ixobrychus exilis*	CSC, MSCS	Could nest along the Sacramento River if suitable habitat is present.
Lesser sandhill crane (wintering)	*Grus canadensis canadensis*	CSC	Does not breed in California. Unlikely to use the Sacramento River corridor during winter or migration.
Little willow flycatcher (nesting)	*Empidonax traillii brewsteri*	CE, MSCS	Unlikely to breed in the primary study area because of the area's elevation, but may use riparian woodlands during migration.
Loggerhead shrike (nesting)	*Lanius ludovidianus*	CSC	Likely to nest and forage in woodlands and scrub habitats in the primary study area.
Long-billed curlew (nesting)	*Numenius americanus*	MSCS	Does not breed in the primary study area. Unlikely to use the Sacramento River corridor during winter or migration.
Long-eared owl (nesting)	*Asio otus*	CSC, MSCS	Does not nest in lowland Central Valley areas. Unlikely to forage along the Sacramento River corridor where flows would be altered.
Northern harrier (nesting)	*Circus cyaneus*	CSC, MSCS	Likely to occur. Suitable nesting and foraging habitat is present in the primary study area.
Northern spotted owl (nesting) (critical habitat)	*Strix occidentalis caurina*	FT, MSCS	Unlikely to occur along the Sacramento River corridor because of a lack of suitable habitat. Critical habitat does not occur in the primary study area.
Osprey (nesting)	*Pandion haliaetus*	MSCS	Known to nest along the Sacramento River in the primary study area.
Purple martin (nesting)	*Progne subis*	CSC	Could occur. Potentially suitable habitat is present along the Sacramento River corridor.
Short-eared owl (nesting)	*Asio flammeus*	CSC, MSCS	Could occur. Potentially suitable habitat is present in the primary study area.

Table 13-5. Special-Status Wildlife Species Known or with Potential to Occur in the Primary Study Area, Along the Sacramento River from Shasta Dam to Red Bluff Pumping Plant (contd.)

Common Name	Scientific Name	Status[1]	Potential for Occurrence
Snowy egret (rookery)	*Egretta thula*	MSCS	Could nest in trees adjacent to the Sacramento River.
Swainson's hawk (nesting)	*Buteo swainsoni*	CT, USFS S, MSCS	Could occur. Suitable nesting and foraging habitat is present in the primary study area.
Tricolored blackbird (nesting colony)	*Agelaius tricolor*	CSC, MSCS	Could occur. Potentially suitable habitat is present in the primary study area.
Western yellow-billed cuckoo (nesting)	*Coccyzus americanus occidentalis*	FT, CE, USFS S, MSCS	Likely to nest and forage in the primary study area.
Western burrowing owl (burrow sites)	*Athene cunicularia hypugea*	CSC, MSCS	Unlikely to occur along the Sacramento River corridor because of a lack of suitable nesting habitat.
White-tailed kite (nesting)	*Elanus leucurus*	CP, MSCS	Likely to occur. Suitable nesting and foraging habitat is present in the primary study area.
Yellow-breasted chat (nesting)	*Icteria virens*	CSC, MSCS	Likely to nest and forage in the primary study area
Yellow warbler (nesting)	*Setophaga (Dendroica) petechia*	CSC, MSCS	Could nest and forage in the primary study area. Likely to use riparian woodlands during migration.
Pacific fisher	*Martes pennanti*	FC, CSC, USFS S	Unlikely to occur. No suitable habitat is available along the Sacramento River corridor.
Ringtail	*Bassariscus astutus*	CP, MSCS	Could occur. Potentially suitable habitat is present along the Sacramento River corridor.
Pallid bat	*Antrozous pallidus (roosting)*	CSC, BLM S, USFS S	Could occur. Potentially suitable habitat is present in woodland in the primary study area.
Western mastiff bat (roosting)	*Eumops perotis californicus*	CSC, BLM S, MSCS	Unlikely to roost along the Sacramento River corridor because suitable roost sites are lacking.

Key:
BLM = U.S. Department of the Interior, Bureau of Land Management
CE = California endangered
CSC = California Species of Special Concern
CP = California fully protected
CT = California threatened
FC = Federal candidate for listing
FD = Federally delisted
FE = Federally endangered
FPD = Proposed for Federal delisting
FT = Federally listed as threatened
S = Sensitive
MSCS = Multi Species Conservation Strategy
USFS = U.S. Department of Agriculture, Forest Service

Biological Resource Assessments for Potential Sacramento River Downstream Habitat Restoration Areas Reclamation conducted biological resource assessments at each of the six potential Sacramento River downstream habitat restoration areas during 2013. The assessments include botanical surveys for special-status plants and noxious weeds, vegetation and wildlife habitat mapping, general wildlife surveys, breeding bird surveys, California red-legged frog habitat assessments, and delineations of Waters of the U.S. The biological resource assessment results are included as Attachments 12-17 to the Wildlife Resources Technical Report in the Biological Resources Appendix. Potentially occurring special-status wildlife species at the potential Sacramento River downstream habitat restoration areas are documented in Attachments 18-23 to the Wildlife Resources Technical Report in the Biological Resources Appendix

Table 13-6. Wildlife Species of Concern in the Potential Sacramento River Downstream Habitat Restoration Areas

Common Name	Scientific Name	Status	Potential for Occurrence
Valley elderberry longhorn beetle	*Desmocerus californicus dimorphus*	FT	Potentially occurring in blue elderberry shrubs.
California red-legged frog	*Rana draytonii*	FT, CSC, MSCS m	Potentially occurring at restoration sites or locations in the vicinity with potential breeding habitat present.
Western pond turtle	*Actinemys marmorata*	CSC, USFS S, MSCS m	Potentially occurring in stream or other wetland habitats. Adjacent upland habitats are potential nesting areas.
Double-crested cormorant	*Phalacrocorax auritus*	MSCS m	Commonly occurs in the general vicinity in riverine and adjacent riparian habitats. No known rookery sites at any potential Sacramento River downstream habitat restoration areas.
Great egret	*Ardea alba*	MSCS m	Commonly occurs in the general vicinity in riverine and adjacent riparian habitats. No known rookery sites at any potential Sacramento River downstream habitat restoration areas.
Great blue heron	*Ardea herodias*	MSCS m	Commonly occurs in the general vicinity in riverine and adjacent riparian habitats. No known rookery sites at any potential Sacramento River downstream habitat restoration areas.
Black-crowned night heron	*Nycticorax nycticorax*	MSCS m	Commonly occurs in the general vicinity in riverine and adjacent riparian habitats. No known rookery sites at any potential Sacramento River downstream habitat restoration areas.
Cooper's hawk	*Accipiter cooperi*	MSCS m	Potentially occurring in forested riparian and woodland habitats.
Bald eagle	*Haliaeetus leucocephalus*	FD, FB, CE, CP, USFS S, MSCS m, BLMS	Occurs year-round in the vicinity. Two known nests in the general vicinity of the potential Sacramento River downstream habitat restoration areas
Osprey	*Pandion haliaetus*	MSCS m	Commonly occurs in the general vicinity of the potential Sacramento River downstream habitat restoration areas. No known nests at any potential Sacramento River downstream habitat restoration areas.

Table 13-6. Wildlife Species of Concern in the Potential Sacramento River Downstream Habitat Restoration Areas (contd.)

Common Name	Scientific Name	Status	Potential for Occurrence
Western yellow-billed cuckoo	*Coccyzus americanus occidentalis*	FT, CE	Occurs only along the upper Sacramento Valley portion of the Sacramento River from Colusa to Red Bluff, the Feather River in Sutter Co., the South Fork Kern River in Kern Co., the Owen's River in Inyo Co., and along the Santa Ana, Amargosa, and lower Colorado Rivers. Riparian forest habitats in the potential Sacramento River downstream habitat restoration areas provide potential nesting habitat; however, these areas is located approximately 24 miles north of the northern extent of the known species geographic range.
Barrows goldeneye	*Bucephala islandica*	—/SC	Winter visitor to bays, lagoons, estuaries, freshwater lakes and large fast-moving rivers. Formerly nested in California at high mountain lakes. Regularly occurs on the Sacramento River in the Redding area during winter.
Willow flycatcher	*Empidonax traillii*	CE, USFS S, MSCS r	Uncommon migrant species in riparian habitat; may occur briefly during migration. No potentially nesting habitat present.
Yellow warbler	*Dendroica petechia brewsteri*	CSC, MSCS r	Potentially occurring in riparian habitats.
Yellow-breasted chat	*Icteria virens*	CSC, MSCS m	Potentially occurring in riparian habitats.
Pallid bat	*Antrozous pallidus*	CSC, USFS S, BLMS	Potentially occurring in riparian forest and woodland habitats.
Townsend's big-eared bat	*Plecotus townsendii*	CSC, USFS S	Potentially occurring in riparian forest and woodland habitats.
Western red bat	*Lasiurus blossevillii*	CSC	Potentially occurring in riparian forest and woodland habitats.
Ringtail	*Bassariscus astutus*	CP, MSCS m	Potentially occurring in riparian forest and woodland habitats.

Key:
BLM S = U.S. Department of the Interior, Bureau of Land Management sensitive
CD= California delisted
CE = California endangered
CP = California fully protected
CSC = California species of special concern
CT = California threatened
FB = Federal Bald and Golden Eagle Protection Act
FC = Federal candidate for listing
FD = Federally delisted
FP = Federally petitioned for listing
FPD = Proposed for Federal delisting
FT = Federally listed as threatened
m = Maintain. Ensure that any adverse effects on the species that could be associated with implementation of CALFED Bay-Delta Program actions will be fully offset through implementation of actions beneficial to the species.
MSCS = Multi-Species Conservation Strategy covered species
r = Contribute to recovery. Implement some of the actions deemed necessary to recover species' populations in the Multi-Species Conservation Strategy focus area.
USFS M = U.S. Department of Agriculture, Forest Service survey and manage species
USFS S = U.S. Department of Agriculture, Forest Service sensitive

Lower Sacramento River and Delta

Numerous special-status wildlife species are associated with riparian, floodplain, and side-channel wetland habitats along the Sacramento River and in the Delta (Table 13-7). However, as stated above, the roughly 300 miles of the Sacramento River can be subdivided into distinct reaches. The reaches in the extended study area are discussed separately below because of differences in morphology, riparian vegetation, and habitat functions. The sensitive species discussed in this section are representative species selected from the many species present in the extended study area and are presented as examples to illustrate the breadth of resources. The *Wildlife Resources Technical Report* contains a comprehensive list of all sensitive wildlife species in the extended study area that have been reported to the CNDDB.

Table 13-7. Representative Sensitive Wildlife Species of Riparian and Perennial Wetland Communities Along the Sacramento River and in the Delta

Common Name	Scientific Name	Status[1]	Habitat Description
Invertebrates			
Valley elderberry longhorn beetle	*Desmocerus californicus dimorphus*	FT	Elderberries in riparian woodlands or savanna communities.
Reptiles			
Western pond turtle	*Actinemys (Clemmys) marmorata*	CSC	Ponds, lakes, rivers, streams, creeks, marshes, and irrigation ditches with abundant vegetation and either rocky or muddy bottoms, in woodland, forest, and grassland.
Giant garter snake	*Thamnophis giga*	FT CT	Marshes, sloughs, drainage canals, and irrigation ditches, especially around rice fields, and occasionally in slow-moving creeks from sea level to 400 feet. Prefers locations with vegetation close to the water for basking.
Birds			
Tricolored blackbird	*Agelaius tricolor*	CSC	*Foraging:* On ground in croplands, grassy fields, flooded land, and along edges of ponds. *Nesting:* Dense cattails, tules, or thickets near fresh water.
Swainson's hawk	*Buteo swainsoni*	CT	*Foraging:* Open desert, grassland, or cropland containing scattered, large trees or small groves. *Nesting:* Open riparian habitat, in scattered trees or small groves in sparsely vegetated flatlands. Usually found near water in the Central Valley.
Northern harrier	*Circus cyaneus*	CSC	*Nesting:* Tall grasses and forbs in emergent wetland, along rivers or lakes, grasslands, grain fields, or on sagebrush flats several miles from water.
Western yellow-billed cuckoo	*Coccyzus americanus occidentalis*	FT CE	*Nesting:* Extensive deciduous riparian thickets or forests with dense, low-level or understory foliage adjacent to slow-moving watercourses, backwaters, or seeps. Willow is almost always a dominant component of the vegetation. In the Sacramento Valley, also uses adjacent walnut orchards.
Yellow warbler	*Setophaga (Dendroica) petechia*	CSC	*Nesting*: Low, open-canopy riparian deciduous woodlands with a heavy brush understory; sometimes in montane shrubbery in open conifer forests.

Table 13-7. Representative Sensitive Wildlife Species of Riparian and Perennial Wetland Communities Along the Sacramento River and in the Delta (contd.)

Common Name	Scientific Name	Status[1]	Habitat Description
White-tailed kite	*Elanus leucurus*	FP	*Foraging:* Undisturbed, open grasslands, meadows, farmlands, and emergent wetlands. *Nesting:* Large groves of dense, broad-leafed deciduous trees close to foraging areas.
Greater sandhill crane	*Grus canadensis tabida*	CT FP	*Foraging: Open grasslands, grain fields, and open wetlands.* *Roosting: In flocks standing in moist fields or in shallow water.* *Nesting: Open habitats with shallow lakes and fresh emergent wetlands.*
Bald eagle	*Haliaeetus leucocephalus*	CE FP	*Foraging: Large bodies of water or free-flowing rivers with abundant fish and adjacent snags or other perches.* *Nesting: Large, old-growth trees or snags in remote, mixed stands near water.*
Yellow-breasted chat	*Icteria virens*	CSC	*Foraging and nesting:* Riparian thickets of willow and other brushy species near streams or other watercourses.
California black rail	*Laterallus jamaicensis coturniculus*	CT FP	*Foraging and nesting:* Tidal emergent wetlands dominated by pickleweed, in the high wetland zones near upper limit of tidal flooding, or in brackish marshes supporting bulrushes and pickleweed. In freshwater, usually found in bulrushes, cattails, and saltgrass adjacent to tidal sloughs.
Suisun song sparrow	*Melospiza melodia maxillaries*	CSC	*Foraging:* The bare surface of tidally exposed mud among tules and along slough margins in brackish marshes. *Nesting:* Along edges of sloughs and bays supporting mixed stands of bulrush, cattail, and other emergent vegetation.
Bank swallow	*Riparia riparia*	CT	*Foraging:* Open riparian areas, grassland, wetlands, water, and cropland. *Nesting:* Vertical banks and cliffs with fine-textured or sandy soils near streams, rivers, ponds, and lakes.
Yellow-headed blackbird	*Xanthocephalus xanthocephalus*	CSC	*Foraging:* Fresh emergent wetland and sometimes along shorelines and in nearby open fields, preferably on moist ground. *Nesting:* Dense emergent wetland of cattails and tules, often along border of lake or pond.

Table 13-7. Representative Sensitive Wildlife Species of Riparian and Perennial Wetland Communities Along the Sacramento River and in the Delta (contd.)

Common Name	Scientific Name	Status[1]	Habitat Description
Mammals			
Pallid bat	*Antrozous pallidus*	CSC	*Foraging:* Relatively open oak woodlands, over water near riparian and upland forests and woodlands, and orchards and vineyards. *Roosting:* Rocky outcrops, cliffs, and crevices.
Western mastiff bat	*Eumops perotis*	CSC	*Foraging:* Over water in broad, open areas near riparian and upland forests and woodlands. *Roosting:* Crevices in vertical cliffs, usually granite or consolidated sandstone, and in broken terrain with exposed rock faces.
Western red bat	*Lasiurus blossevillii*	CSC	*Foraging:* Over water edges in open areas near riparian and upland forests and woodlands; orchards. *Roosting:* Trees along edges or in habitat mosaics in a variety of habitats and orchards.
Townsend's big-eared bat	*Plecotus townsendii*	CSC	*Foraging:* Water edges in open areas near riparian and upland forests and woodlands. *Roosting:* Caves, mines, tunnels, buildings, or other human-made structures in woodlands. Prefers mesic habitats.
Salt-marsh harvest mouse	*Reithrodontomys raviventris*	FE CE FP	Salt marsh dominated by pickleweed and salt grass. Generally requires nonsubmerged, salt-tolerant vegetation for escape during high tides.

Source: CNDDB 2012

Note:

[1] Status definitions:

Key:

CE = California listed as endangered
CSC = California species of special concern
CT = California listed as threatened
FC = federal candidate for listing
FE = Federally listed as endangered
FP = California fully protected
FT = Federally listed as threatened

Sacramento River from Red Bluff Pumping Plant to the Delta Many of the special-status wildlife species described above for the upper Sacramento River have the potential to occur in the middle and lower reaches of the Sacramento River. Wildlife species listed under the Federal Endangered Species Act (ESA) and/or California Endangered Species Act (CESA) that have the potential to occur in a portion of the extended study area from Red Bluff Pumping Plant to the Delta include valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*), giant garter snake (*Thamnophis gigas*), bald eagle (*Haliaeetus leucocephalus*), Swainson's hawk (*Buteo swainsoni*), western yellow-billed cuckoo (*Coccyzus americanus occidentalis*), willow flycatcher (*Empidonax traillii*), and bank swallow (*Riparia riparia*).

Sacramento–San Joaquin River Delta Many special-status species are known or likely to occur in the Delta because of the presence of extensive wetland habitats. Tidal marshes and emergent wetlands support several special-status wildlife species: California black rail (*Laterallus jamaicensis coturniculus*), California clapper rail (*Rallus longirostris obsoletus*), greater sandhill crane (*Grus canadensis tabida*), salt marsh common yellowthroat (*Geothlypis trichas sinuosa*), salt marsh harvest mouse (*Reithrodontomys raviventris*), Suisun ornate shrew (*Sorex ornatus sinuosus*), Suisun song sparrow (*Melospiza melodia maxillaris*), and tricolored blackbird (*Agelaius tricolor*). The giant garter snake is known to inhabit sloughs, canals, and low-gradient streams and freshwater marshes in the Delta. Vernal pools and other freshwater seasonal wetlands support several special-status crustaceans, including vernal pool tadpole shrimp (*Lepidurus packardi*) and vernal pool fairy shrimp (*Branchinecta lynchi*). The valley elderberry longhorn beetle has been found in the Delta region on McCormack-Williamson and New Hope tracts (CNDDB 2012).

San Joaquin River Basin to the Delta The current wildlife habitat value of this area is somewhat limited by the predominance of agricultural lands, which support a relatively low diversity of wildlife species. Remnant native vegetation patches are likely to support a high diversity of wildlife species. More than 100 special-status wildlife and plant species occur in the San Joaquin River region. Most of the special-status wildlife species are associated with grasslands (which include vernal pools), freshwater emergent wetlands, lakes, and rivers that occur on the valley floor. Many of the species have been listed by Federal and State wildlife agencies because of habitat losses associated with agricultural development and water projects.

CVP/SWP Service Areas

The CVP and SWP service areas are dominated by agricultural land and urban development. These areas support many wildlife species, most of which are highly adapted to these altered environments. The conflict between urban growth and conservation of native habitat has resulted in the listing of a number of wildlife species that were threatened with extinction. The region also supports a variety of exotic species, some of which are detrimental to survival of native species.

The California condor (*Gymnogyps californianus*), lightfooted clapper rail (*Rallus longirostris levipes*), California least tern (*Sternula antillarum brownie*), least Bell’s vireo (*Vireo bellii pusillus*), Belding’s Savannah sparrow (*Passerculus sandwichensis beldingi*), southwestern willow flycatcher (*Empidonax traillii extimus*), California gnatcatcher (*Polioptila californica*), Mohave ground squirrel (*Spermophilus mohavensis*), and Morro Bay kangaroo rat (*Dipodomys heermanni morroensis*) are examples of species that have been listed as threatened or endangered under the ESA and/or CESA and that could occur within the CVP and SWP service areas.

13.1.3 Other Wildlife Resources

Shasta Lake and Vicinity

Critical Deer Range Critical black-tailed deer winter range for the McCloud Flats and Cow Creek herds is located in the Shasta Lake and vicinity portion of the primary study area in all five arms of the lake. Critical fawning range also is found along the south-facing slopes of Little Sugarloaf Creek (CDFG 1998). Critical deer winter range can include movement corridors, staging areas where deer congregate, and habitats with high-quality winter forage or other elements that help deer to survive the winter. Winter ranges are at lower elevations and are fewer in number than summer ranges, and thus are more vulnerable to human impact. Deer from different summer ranges may use common winter ranges when breeding typically occurs, which contributes to genetic diversity (CDFG 1998).

USFWS Habitat Evaluation Procedure Analysis Reclamation is working with USFWS to complete a Habitat Evaluation Procedure analysis to help quantify potential project impacts and meet Fish and Wildlife Coordination Act consultation requirements. To date, Habitat Evaluation Procedure studies and analyses have been completed for part of the Shasta Lake and vicinity portion of the primary study area. Additional planning and coordination are ongoing.

Incidental Observations Reclamation maintains a database of special-status wildlife species incidentally observed during all biological surveys performed since 2002. The incidental species observations include the foothill yellow-legged frog, western pond turtle (*Actinemys marmorata*), osprey (*Pandion haliaetus*), peregrine falcon (*Falco peregrinus anatum*), yellow-breasted chat (*Icteria virens*), yellow warbler (*Dendroica petechia brewsteri*), and Townsend's big-eared bat (*Plecotus townsendii*) (Figures 13-5a through 13-5f).

Upper and Lower Sacramento River, Delta, and CVP/SWP Service Areas

For the upper and lower Sacramento River, Delta, and CVP/SWP service areas, no other wildlife resources were evaluated in addition to wildlife habitats, wildlife, and special-status wildlife as described previously in Sections 13.1.1 and 13.1.2.

13.2 Regulatory Framework

Biological resources in California are protected and/or regulated by a variety of Federal and State laws and policies. Key regulatory and conservation planning issues applicable to the project and alternatives under consideration are discussed below.

13.2.1 Federal

Federal Endangered Species Act

Pursuant to the ESA, USFWS and NMFS have authority over projects that may result in "take" of a Federally listed species. In general, ESA Section 7 prohibits persons (including private parties) from "taking" listed endangered or threatened fish and wildlife species on private property, and from "taking" listed endangered or threatened plant species in areas under Federal jurisdiction or in violation of State law (16 U.S. Code (USC) 1532, 50 Code of Federal Regulations (CFR) 17.3).

Under the ESA, the definition of "take" is to "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct" as part of an intentional or negligent act or omission. The term "harm" includes acts that result in death or injury to wildlife. Such acts may include significant habitat modification or degradation if it results in death or injury to wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering.

Section 7(a) of the ESA, as amended, requires Federal agencies to evaluate their actions with respect to any species that is proposed for listing or is listed as endangered or threatened. Section 7(a)(2) requires Federal agencies to ensure that activities they authorize, fund, or carry out are not likely to jeopardize the continued existence of a listed species or to destroy or adversely modify its designated critical habitat. If a Federal action may affect a listed species or its designated critical habitat, the responsible Federal agency must enter into formal consultation with USFWS or NMFS, depending on the species.

As defined in the ESA, critical habitat is a specific geographic area that is essential for the conservation of a threatened or endangered species and that may require special management and protection. It may include an area that is not currently occupied by the species but that will be needed for its recovery. Critical habitats are designated to ensure that actions authorized by Federal agencies will not destroy or adversely modify designated critical habitat, thereby protecting areas necessary for the conservation of the species.

Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act (16 USC 661–667e, as amended) provides the basic authority for the involvement of USFWS in evaluating impacts on fish and wildlife from proposed water resource development projects. It requires that fish and wildlife resources receive consideration equal to that of other project features. It also requires Federal agencies that construct, license, or permit water resource development projects to first consult with USFWS (and NMFS in some instances) and State fish and wildlife agencies regarding the impacts of the proposed action on fish and wildlife resources and measures to mitigate these impacts.

Bald Eagle Protection Act

The bald eagle and golden eagle are Federally protected under the Bald Eagle Protection Act (16 USC 668–668c). It is illegal to take, possess, sell, purchase, barter, offer to sell or purchase or barter, transport, export, or import a live or dead bald or golden eagle or any eagle part, nest, or egg unless authorized by the Secretary of the Interior. The Bald Eagle Protection Act defines "take" as "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb" (16 USC 668–668d). USFWS has further defined "disturb" under the act as follows (72 *Federal Register* 31132–31140 (June 5, 2007)):

> *Disturb means to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, (1) injury to an eagle; (2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior; or (3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior.*

Active nest sites are also protected from disturbance during the breeding season, generally January through August.

USFWS has proposed new permit regulations to authorize the take of bald and golden eagles under the Bald Eagle Protection Act, generally where the take to be authorized is associated with otherwise lawful activities (72 *Federal Register* 31141–31155 (June 5, 2007)). With the delisting of the bald eagle from the ESA in 2007, this act is the primary law protecting bald eagles and golden eagles. Violators are subject to fines and/or imprisonment for up to 1 year.

Migratory Bird Treaty Act

Migratory birds are protected under the Migratory Bird Treaty Act (MBTA) of 1918 (16 USC 703–711). The MBTA makes it unlawful to take, possess, buy, sell, purchase, or barter any migratory bird listed in 50 CFR Part 10, including feathers or other parts, nests, eggs, or products, except as allowed by implementing regulations (50 CFR 21). This prohibition includes direct and indirect acts, although harassment and habitat modifications are not included unless they result in direct loss of birds, nests, or eggs. The current list of species protected by the MBTA, which can be found in Title 50, Section 10.13 of the CFR, includes several hundred species, essentially all native birds. Loss of nonnative species, such as house sparrows (*Passer domesticus*), European starlings (*Sturnus vulgaris*), and rock pigeons (*Columba livia*), is not covered by this statute.

U.S. Forest Service Sensitive Species

The National Forest Management Act requires USFS to "provide for a diversity of plant and animal communities" (16 USC 1604(g)(3)(B)) as part of its multiple-use mandate. USFS must maintain "viable populations of existing native and desired nonnative species in the planning area" (36 CFR 219.19). The Sensitive Species program is designed to meet this mandate and to demonstrate USFS's commitment to maintaining biodiversity on National Forest System lands. The program is a proactive approach to conserving species to prevent a trend toward listing under the ESA and to ensure the continued existence of viable, well-distributed populations. A "Sensitive Species" is any species of plant or animal that has been recognized by the Regional Forester to need special management to prevent the species from becoming threatened or endangered.

Shasta-Trinity National Forest Land and Resource Management Plan

The *Shasta-Trinity National Forest Land and Resource Management Plan* (STNF LRMP) contains forest goals, standards, and guidelines designed to guide the management of the Shasta-Trinity National Forest. The following goals, standards, and guidelines related to wildlife resource issues associated with the study area were excerpted from the *Shasta-Trinity National Forest Land and Resource Management Plan* (USFS 1995).

Biological Diversity

Goals (STNP LRMP, p. 4-4) Integrate multiple resource management on a landscape level to provide and maintain diversity and quality of habitats that support viable populations of plants, fish, and wildlife.

Standards and Guidelines (STNF LRMP, p. 4-14)

- **Natural Openings –** Management of natural openings will be determined at the project level consistent with desired future conditions.

- **Snags –** Over time, provide the necessary number of replacement snags to meet density requirements as prescribed for each land allocation and/or management prescription. Live, green culls and trees exhibiting decadence and/or active wildlife use are preferred.

- **Hardwood –** Apply the following standards in existing hardwood types:

  - Manage hardwood types for sustainability.

  - Conversion to conifers will only take place to meet desired future ecosystem conditions.

  - Where hardwoods occur naturally within existing conifer types on suitable timber lands, manage for a desired future condition for hardwoods as identified during ecosystem analysis consistent with management prescription standards and guidelines. Retain groups of hardwoods over single trees.

Threatened, Endangered, and Sensitive Species (Plants and Animals)

Goals (STNF LRMP, p. 4-5)

- Monitor and protect habitat for Federally listed Threatened and Endangered and candidate species. Assist in recovery efforts for Threatened and Endangered species. Cooperate with the State to meet objectives for State-listed species.

- Manage habitat for sensitive plants and animals in a manner that will prevent any species from becoming a candidate for Threatened and Endangered status.

Goals (STNF LRMP, p. 4-6)

- Meet habitat or population objectives established for management indicators.
- Cooperate with Federal, State, and local agencies to maintain or improve wildlife habitat.
- Maintain natural wildlife species diversity by continuing to provide special habitat elements within Forest ecosystems.

Standards and Guidelines (STNF LRMP, pp. 4-29 through 4-30)

- Minimize accidental electrocution of raptors by ensuring that newly constructed overhead power lines meet safe design standards.
- Consider transplants, introductions, or reintroductions of wildlife species only after ecosystem analysis and coordination with other agencies and the public.
- Manage habitat for neotropical migrant birds to maintain viable population levels.
- Develop interpretation/view sites for wildlife viewing, photography, and study. Provide pamphlets, slide shows, and other educational material that enhance the watchable wildlife and other interpretive programs.
- Maintain and/or enhance habitat for Federally listed threatened and endangered or USFS sensitive species consistent with individual species recovery plans.

U.S. Forest Service Survey and Manage

Standards and Guidelines The 1994 ROD for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl and Standards and Guidelines for Management for Late-Successional and Old-Growth Related Species in the Range of the Northern Spotted Owl (NWFP ROD) amended or was incorporated into BLM and USFS land management plans to require certain actions for rare amphibians, mammals, bryophytes, mollusks, vascular plants, fungi, lichens, and arthropods that occupy late-successional and old-growth forests (USFS and BLM 1994). These rare species were identified in Appendix C of the NWFP ROD collectively as S&M species. The NWFP ROD also established protection buffers on matrix lands for certain species (i.e., protection buffer species) that were not on the 1994 S&M list and required that those buffers be managed as part of the Late Successional Reserve network. Four survey strategies were developed to guide management of S&M species: (1) manage known sites, (2) survey before ground-disturbing activities, (3) conduct extensive surveys, and (4) conduct general regional surveys.

The NWFP ROD also established overall objectives for managing S&M species populations that were referred to as “persistence objectives.” These objectives were based on the USFS viability provision in the 1982 National Forest System Land and Resource Management Planning Regulation for the National Forest Management Act of 1976. This provision is targeted toward vertebrate species, but also was applied to nonvertebrate species to the greatest extent practicable, as described in the NWFP ROD. The provision generally states that the USFS will manage habitat “to maintain viable populations of existing native and desired non-native vertebrate species in the planning area” (36 CFR 219.19). Although the viability standard is part of the USFS planning regulations, the protections for S&M species were also applied to BLM lands in the NWFP ROD with a goal of protecting the long-term health and sustainability of all Federal forests within the range of the northern spotted owl and the species that inhabit them. Because of the uncertainty associated with the continued persistence of species due to natural factors, the NWFP ROD noted that compliance with the planning regulations is not subject to precise numerical interpretations and cannot be fixed at any single threshold; rather, “as in any administrative field, common sense and agency expertise must be applied” (NWFP ROD, p. 44).

The 2001 S&M ROD (USFS and BLM 2001) modified the management direction provided in the NWFP ROD for S&M and protection buffer species and amended BLM and USFS land management plans in the range of the northern spotted owl accordingly. The list of S&M species was also modified to remove 72 species in all or part of their range because new information indicated they were secure or otherwise did not meet the basic criteria for S&M. Species remaining on the list were assigned to one of six categories using the following criteria: their relative rarity, the ability to reasonably and consistently locate occupied sites during surveys before habitat- disturbing activities, and the level of information known about the species or group of species. The 2001 S&M ROD also removed the direction specific to protection buffer species, excluding these species from S&M Standards and Guidelines requirements. As part of the 2001 Standards and Guidelines, objectives, criteria, and management direction were defined for each category. Specific criteria were also established to add, remove, or change species categories based on new information and as part of the annual species review processes.

In 2004 and again in 2007, the BLM and USFS issued a ROD to eliminate the S&M requirements of the 2001 S&M ROD and to provide protection for species on the S&M lists by managing them under the agencies’ special-status species programs. As a result of litigation, the requirements of the 2001 S&M ROD were reinstated. In a subsequent court-mandated settlement agreement (USFS and BLM 2011), the list of S&M species was modified. The settlement agreement also made the following modifications: (1) acknowledged existing exemption categories (2006 Pechman Exemptions), (2) updated the 2001 S&M species list, (3) established a transition period for application of the species list, and (4) established new exemption categories (2011 Exemptions). Agency decisions made after September 30, 2012, are required to use the 2011 S&M list. Some species considered in the S&M program also occur on non-Federal lands. The requirements of the 1994 NWFP ROD and 2001 S&M ROD as modified under the 2011 Settlement Agreement apply only to lands managed by the BLM and USFS within the range of the northern spotted owl. The 2011 Settlement Agreement was later struck down by the court and the S&M program has reverted to the requirements of the 2001 S&M ROD with the 2006 Pechman Exemptions still intact.

Management Guide for the Shasta and Trinity Units of the Whiskeytown-Shasta-Trinity National Recreation Area

The *Management Guide for the Whiskeytown-Shasta-Trinity National Recreation Area*, including the Shasta Unit of the NRA, contains management guidance intended to achieve or maintain a desired condition (USFS 2014). These strategies take into account opportunities, management recommendations for specific projects, and mitigation measures needed to achieve specific goals. The following guidance relative to wildlife resource issues associated with the project site were excerpted from the management guide.

Maintaining Key Wildlife Habitat Components

- Limestone outcrops within the Shasta Unit are recognized as a unique habitat component for various wildlife species. The cool moist microclimate present within these outcrops provides the habitat to escape the hot, dry summer season. Maintaining limestone habitats is a top priority within the NRA. Actions which could negatively impact limestone habitats (road building, dozer-line construction, piling and burning) will be avoided if limestone habitats would be degraded.

- Due to the important role down woody material and snags play in the ecosystem, design projects to maintain large down logs and large snags. In general, down logs and snags will be retained unless they pose a direct risk to public safety. It is recognized that projects implementing prescribed fire will directly impact large snags and logs. These projects are encouraged, as they are essential in maintaining a healthy and diverse ecosystem. It is also recognized that the effects of prescribed fire on snags and down logs is a dynamic process, as fire will consume some snags and logs, but also some trees are killed by fire, which provides for recruitment of new snags and logs.

- Bald eagle nest territories will be inventoried and vegetation management plans will be developed to ensure that suitable nest and perch trees are maintained over time.

- Chaparral and woodland habitat management will occur to meet wildlife objectives.
- Interpretive materials will address the need to conserve rare plant communities in accordance with the NRA Interpretive Plan.
- Diversity of native species will be emphasized. Eradication program will be implemented for nonnative, introduced species in areas where healthy, botanically diverse plant communities are necessary to meet ecosystem management objectives.

Wildlife

- Management activities will assure population viability for all native and nonnative desirable species. Management to insure viability will occur within occupied habitat for bald eagle, peregrine falcon, northern spotted owl, northern goshawk, willow flycatcher, northwestern pond turtle, Pacific fisher, Shasta salamander, and other special-status species in accordance with species and/or territory management plans, Forest Orders, and appropriate laws and policy.
- Surveys will continue within potential suitable habitats to determine occupancy status for Threatened, Endangered, sensitive, and candidate species.
- Cooperation will continue with the CDFW and the USFWS regarding habitat management of wildlife species inhabiting the National Recreation Area. Consultation with USFWS will continue regarding habitat management for threatened and endangered species.

U.S. Bureau of Land Management Resource Management Plan

BLM manages a number of public land areas within the primary study area, including the Shasta/Chappie Off-Highway Vehicle Area west of Shasta Dam. These areas fall under the Northern California BLM district and the resource management plan of the Redding BLM field office. The purpose of BLM’s resource management plans is to provide overall direction for managing and allocating public resources in the planning area. BLM is responsible for administering the following strategies related to resource issues common to the portion of the Redding Resource Area lands located near the study area and vicinity (BLM 1992, 1993, 2005).

- Provide a regional opportunity for motorized recreation with a focus within the Shasta/Chappie Off-Highway Vehicle Area.
- Enhance non-motorized recreation opportunities within the area via a greenway connecting Redding to Shasta Dam along the Sacramento River.

- Maintain or improve the long-term sustained yield of forest products available from commercial forest lands.
- Improve the long-term condition and protection of deer winter range habitat.
- Maintain special-status species habitat.
- Maintain the existing scenic quality of the areas.
- Maintain opportunities to explore and develop freely available minerals on public lands.

Section 404 of the Clean Water Act

USACE regulates discharges of dredged or fill materials into waters of the United States under Section 404 of the Clean Water Act. Waters of the United States include lakes, rivers, streams, and relatively permanent tributaries and adjacent wetlands. Wetlands are defined under Section 404 as areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support (and that do support under normal circumstances) a prevalence of vegetation typically adapted for life in saturated soil conditions. Activities that require a permit under Section 404 include but are not limited to placing fill or riprap, grading, mechanized land clearing, and dredging. Any activity that results in the deposit of dredged or fill material below the ordinary high-water mark of waters of the United States or within a jurisdictional wetland usually requires a Section 404 permit, even if the area is dry at the time the activity takes place.

Executive Order 11312: Invasive Species

Executive Order 11312 directs Federal agencies to use relevant programs and authorities to do all of the following:

- Prevent the introduction of invasive species
- Detect and respond rapidly to and control populations of such species in a cost-effective and environmentally sound manner
- Monitor invasive species populations accurately and reliably
- Provide for restoration of native species and habitat conditions in ecosystems that have been invaded
- Conduct research on invasive species and develop technologies to prevent introduction and provide for environmentally sound control of invasive species

- Promote public education on invasive species and the means to address them

- Refrain from authorizing, funding, or carrying out actions that it believes are likely to cause or promote the introduction or spread of invasive species in the United States or elsewhere unless, pursuant to guidelines that it has prescribed, the agency has determined and made public its determination that the benefits of such actions clearly outweigh the potential harm caused by invasive species; and that all feasible and prudent measures to minimize risk of harm will be taken in conjunction with the actions

Executive Order 11312 established a national Invasive Species Council made up of Federal agencies and departments and a supporting Invasive Species Advisory Committee composed of State, local, and private entities. The Invasive Species Council and Advisory Committee oversee and facilitate implementation of the executive order, including preparation of a national invasive species management plan.

Executive Order 11990: Protection of Wetlands

Executive Order 11990 established the protection of wetlands and riparian systems as the official policy of the Federal government. It requires all Federal agencies to consider wetland protection as an important part of their policies and take action to minimize the destruction, loss, or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands.

Executive Order 13186: Migratory Birds

Executive Order 13186 directs executive departments and agencies to take certain actions to further implement the MBTA. It requires that each Federal agency taking actions that have, or are likely to have, a measurable negative effect on migratory bird populations develop and implement a memorandum of understanding with USFWS that shall promote the conservation of migratory bird populations.

Executive Order 13443: Facilitation of Hunting Heritage and Wildlife Conservation

Executive Order 13443 directs Federal agencies that have programs and activities that have a measurable effect on public land management, outdoor recreation, and wildlife management, including the U.S. Department of the Interior and the U.S. Department of Agriculture, to facilitate the expansion and enhancement of hunting opportunities and the management of game species and their habitat.

13.2.2 State

California Endangered Species Act

Under the CESA, CDFW has the responsibility for maintaining a list of endangered and threatened species (California Fish and Game Code Section 2070). CDFW also maintains a list of “candidate species,” which are species for which CDFW has issued a formal notice that they are under review for addition to the list of endangered or threatened species. In addition, CDFW maintains lists of “species of special concern,” which serve as species “watch lists.” Pursuant to the requirements of CESA, an agency reviewing a proposed project within its jurisdiction must determine whether any State-listed endangered or threatened species may be present in the project study area and, if so, whether the proposed project would have a potentially significant impact on any of these species. In addition, CDFW encourages informal consultation on any proposed project that may affect a species that is a candidate for state listing.

Project-related impacts on species listed as endangered or threatened under the CESA would be considered significant. State-listed species are protected under the mandates of the CESA. “Take” of protected species incidental to otherwise lawful management activities may be authorized under Section 2081 of the California Fish and Game Code. Under the CESA, “take” is defined as an activity that would directly or indirectly kill an individual of a species, but the definition does not include “harm” or “harass,” as the Federal act does. As a result, the threshold for take under the CESA is higher than that under the ESA.

Authorization from CDFW would be in the form of an incidental take permit or as a consistency determination (Fish and Game Code Section 2080.1(a)). Fish and Game Code Section 2080.1(a) authorizes CDFW to accept a Federal biological opinion (BO) as the take authorization for a State-listed species when a species is listed under both the ESA and the CESA.

Sections 3503 and 3513 of the California Fish and Game Code – Protection of Birds of Prey

Under California Fish and Game Code Section 3503, it is unlawful to take, possess, or needlessly destroy the nest or eggs of any bird, except as otherwise provided in other sections. Section 3503.5 specifically states that it is unlawful to take, possess, or destroy any raptors (birds in the order of Falconiformes or Strigiformes (birds of prey) – i.e., eagles, hawks, owls, and falcons), including their nests or eggs. Section 3513 provides for adoption of the MBTA’s provisions. It states that it is unlawful to take or possess any migratory nongame bird as designated in the MBTA or any part of such migratory nongame bird. These State codes offer no statutory or regulatory mechanism for obtaining an incidental take permit for the loss of nongame, migratory birds. Typical violations include destruction of active raptor nests resulting from removal of vegetation in which the nests are located. Violation of Sections 3503.5 and 3513 could also include disturbance of nesting pairs that results in failure of an active raptor nest.

Fully Protected Species Under the Fish and Game Code

Protection of fully protected species is described in California Fish and Game Code Sections 3511, 4700, 5050, and 5515, which list 37 fully protected species. These statutes prohibit take or possession at any time of fully protected species. CDFW is unable to authorize incidental take of fully protected species when activities are proposed in areas inhabited by those species. CDFW has informed non-Federal agencies and private parties that they must avoid take of any fully protected species in carrying out projects.

Section 1602 of the California Fish and Game Code – Streambed Alteration

Diversions, obstructions, or changes to the natural flow or bed, channel, or bank of any river, stream, or lake in California that supports wildlife resources are subject to regulation by CDFW, pursuant to California Fish and Game Code Section 1602. The regulatory definition of a stream is a body of water that flows at least periodically or intermittently through a bed or channel having banks and supports wildlife, fish, or other aquatic life. This includes watercourses that have a surface or subsurface flow that supports or has supported riparian vegetation. CDFW's jurisdiction within altered or artificial waterways is based on the value of those waterways to fish and wildlife. A CDFW streambed alteration agreement must be obtained for a project that would result in an impact on a river, stream, or lake.

Section 401 Water Quality Certification/Porter-Cologne Water Quality Control Act

Under Section 401 of the Clean Water Act, an applicant for a Section 404 permit must obtain a certificate from the appropriate State agency stating that the intended dredging or filling activity is consistent with the State's water quality standards and criteria. In California, the authority to grant water quality certification is delegated by the State Water Resources Control Board to the nine regional water quality control boards (regional water boards). Each of the regional water boards must prepare and periodically update basin plans for water quality control in accordance with the Porter-Cologne Water Quality Control Act. Each basin plan sets forth water quality standards for surface water and groundwater, as well as actions to control nonpoint and point sources of pollution to achieve and maintain these standards. Basin plans offer an opportunity to protect wetlands through the establishment of water quality objectives. The regional water boards' jurisdiction includes Federally protected waters as well as areas that meet the definition of "waters of the state." A water of the State is defined as any surface water or groundwater, including saline waters, within the boundaries of California. The regional water boards have the discretion to take jurisdiction over areas not Federally protected under Section 401, provided that those areas meet the definition of waters of the State. Mitigation requiring no net loss of wetlands functions and values of waters of the State is typically required by the regional water board.

California Department of Fish and Wildlife Species Designations

CDFW maintains an informal list of species called "species of special concern." These are broadly defined as plant and wildlife species that are of concern to CDFW because of population declines and restricted distributions, and/or because they are associated with habitats that are declining in California. These species are inventoried in the CNDDB regardless of their legal status. Impacts on species of special concern may be considered significant.

13.2.3 Regional and Local

Shasta, Tehama, Glenn, Sutter, Sacramento, and Yolo counties and the cities of Redding, Colusa, and Sacramento have established codes and policies that address protection of natural resources, including vegetation, sensitive species, and trees, and are applicable to the project.

Shasta County's general plan emphasizes that the maintenance and enhancement of quality fish and wildlife habitat is critical to the recreation and tourism industry, and acknowledges that any adverse and prolonged decline of these resources could result in negative impacts on an otherwise vibrant industry. The general plan identifies efforts to protect and restore these habitats to sustain the long-term viability of the tourism and recreation industry (Shasta County 2004).

The City of Redding's general plan strives to strike a balance between development and conservation by implementing several measures, such as creek-corridor protection, sensitive hillside development, habitat protection, and protection of prominent ridge lines that provide a backdrop to the city (City of Redding 2000).

Tehama County's general plan update provides an overarching guide to future development and establishes goals, policies, and implementation measures designed to address potential changes in county land use and development. The general plan identifies the importance of retaining agriculture as one of the primary uses of land in Tehama County (Tehama County 2009).

Glenn County's general plan provides a comprehensive plan for growth and development in Glenn County for the next 20 years (2007–2027). This plan recognizes that public lands purchased for wildlife preservation generate economic activity as scientists and members of the public come to view and study remnant ecosystems (Glenn County 1993).

The City of Colusa's general plan seeks to promote its natural resources through increased awareness and improved public access (City of Colusa 2007).

Sutter County's general plan contains policies that generally address preservation of natural vegetation, including wetlands. It requires that new development mitigate the loss of Federally protected wetlands to achieve "no net loss," but it does not include any other specific requirements (Sutter County 2010).

Sacramento County's general plan contains goals and policies that promote management, protection, and restoration of natural habitats and sensitive species of plants and animals throughout the county (Sacramento County 2011). This includes policies for "no net loss" of riparian and oak woodland. The Sacramento County general plan includes specific setbacks from streams that can be 200 feet wide; development within setbacks is prohibited except for passive recreation and stormwater facilities in the outside-most 50 feet. It also addresses the need to conserve vernal pools and ephemeral wetlands to ensure no net loss of vernal pool acreage. Several policies specifically promote protection of native oak trees, and, in some areas of the county, seek to ensure that there is no net loss of canopy area.

Chapter 12.56, "Trees Generally," of the City of Sacramento Municipal Code addresses the protection of trees within the city boundaries, including general protection of all trees on city property and specific protection of heritage trees.

Yolo County's general plan aims to provide an active and productive buffer of farmland and open space separating the Bay Area from Sacramento, and integrating green spaces into its communities (Yolo County 2009).

13.2.4 Federal, State, and Local Programs and Projects

California Bay-Delta Authority

The California Bay-Delta Authority (CBDA) was established as a State agency in 2003 to oversee implementation of CALFED for the numerous Federal and State agencies working cooperatively to improve the quality and reliability of California's water supplies while restoring the Bay-Delta ecosystem. The July 2000 CALFED *Final Programmatic EIS/EIR* (CALFED 2000c) analyzed a range of alternatives to address these needs and included a MSCS to provide a framework for compliance with ESA, CESA, and Natural Community Conservation Planning Act. The August 2000 CALFED Programmatic ROD identified 12 action plans, including Ecosystem Restoration, Watersheds, and Water Supply Reliability, among others (CALFED 2000d). The Ecosystem Restoration Program has provided a funding source for projects that include those involving acquisition of lands within the Sacramento River Conservation Area, initial baseline monitoring and preliminary restoration planning, and preparation of long-term habitat restoration management and monitoring plans. In 2009, the California Legislature passed sweeping water reform legislation, including the establishment of the Delta Stewardship Council (DSC). The DSC was transferred all the responsibilities, programs, staff and most of the funding from the CBDA, and the CBDA was dissolved. The DSC was also given additional mandates, including the development of a Delta Plan to guide activities and programs of State and local programs in the legal Delta through a consistency determination process.

Cantara Trustee Council

The Cantara Trustee Council administers a grant program that has provided funding for numerous environmental restoration projects in the primary study area, including programs in the Fall River watershed, Sulphur Creek, the upper Sacramento River, Middle Creek, lower Clear Creek, Battle Creek, Salt Creek, and Olney Creek. The Cantara Trustee Council is a potential local sponsor for future restoration actions in the primary study area. The Cantara Trustee Council includes representatives from CDFW, USFWS, the Central Valley RWQCB, the California Sportfishing Protection Alliance, and the Shasta Cascade Wonderland Association.

Resource Conservation Districts

There are numerous resource conservation districts (RCD) within the study area. Once known as soil conservation districts, RCDs were established under California law with a primary purpose to implement local conservation measures. Although RCDs are locally governed agencies with locally appointed, independent boards of directors, they often have close ties to county agencies and the U.S. National Resources Conservation Service. RCDs are empowered to conserve resources within their districts by implementing projects on public and private lands and to educate landowners and the public about resource conservation. They are often involved in the formation and coordination of watershed working groups and other conservation alliances. In the Shasta Lake and upper Sacramento River vicinity, districts include the Western Shasta County RCD and the Tehama County RCD. To the east are the Fall River and Pit River RCDs, and to the west and north are the Trinity County and Shasta Valley RCDs.

Riparian Habitat Joint Venture

The Riparian Habitat Joint Venture (RHJV) was initiated in 1994 and includes signatories from 18 Federal, State, and private agencies. The RHJV promotes conservation and the restoration of riparian habitat to support native bird population through three goals:

- Promote an understanding of the issues affecting riparian habitat through data collection and analysis.
- Double riparian habitat in California by funding and promoting on-the-ground conservation projects.
- Guide land managers and organizations to prioritize conservation actions.

RHJV conservation and action plans are documented in *The Riparian Bird Conservation Plan* (RHJV 2004). The conservation plan targets 14 “indicator” species of riparian-associated birds and provides recommendations for habitat protection, restoration, management, monitoring, and policy. The report notes habitat loss and degradation as one of the most important factors causing the decline of riparian birds in California. The RHJV has participated in monitoring efforts within the Sacramento National Wildlife Refuge Complex and other conservation areas. The RHJV's conservation plan identifies lower Clear Creek as a prime breeding area for yellow warblers (*Setophaga petechia*) and song sparrows (*Melospiza melodia*), advocating a continuous riparian corridor along lower Clear Creek.

Sacramento River Advisory Council

In 1986 the California Legislature passed Senate Bill 1086, which called for a management plan for the Sacramento River and its tributaries to protect, restore, and enhance fisheries and riparian habitat in an area stretching from the confluence of the Sacramento River with the Feather River and continuing northward to Keswick Dam about 4 miles north of Redding. The law established an advisory council that included representatives of Federal and State agencies, county supervisors, and representatives of landowners, water contractors, commercial and sport fisheries, and general wildlife and conservation interests. Responsibilities of the advisory council included development of the *Sacramento River Conservation Area Forum Handbook* (Resources Agency 2003). This action also resulted in formation in May 2000 of the Sacramento River Conservation Area Forum, a nonprofit, public benefit corporation with a board of directors that includes private landowners and public interest representatives from a seven-county area, an appointee of the Resources Agency, and ex-officio members from six Federal and State resource agencies.

Sacramento River Conservation Area Program

The Sacramento River Conservation Area Program has an overall goal of preserving remaining riparian habitat and reestablishing a continuous riparian ecosystem along the Sacramento River between Redding and Chico, and reestablishing riparian vegetation along the river from Chico to Verona. The program is to be accomplished through an incentive-based, voluntary river management plan. The *Upper Sacramento River Fisheries and Riparian Habitat Management Plan* (Resources Agency 1989), identifies specific actions to help restore the Sacramento River fishery and riparian habitat between the Feather River and Keswick Dam. The *Sacramento River Conservation Area Forum Handbook* (Resources Agency 2003) is a guide to implementing the program. The Keswick Dam to Red Bluff portion of the conservation area includes areas within the 100-year floodplain, existing riparian bottomlands, and areas of contiguous valley oak woodland, totaling approximately 22,000 acres. The 1989 fisheries restoration plan recommended several actions specific to the study area:

- Fish passage improvements at Red Bluff Diversion Dam (completed)
- Modification of the Spring Creek Tunnel intake for temperature control (completed)

- Spawning gravel replacement program (ongoing)
- Development of side-channel spawning areas, such as those at Turtle Bay in Redding (ongoing)
- Structural modifications to the Anderson-Cottonwood Irrigation District Dam to eliminate short-term flow fluctuations (completed)
- Maintaining instream flows through coordinated operation of water facilities (ongoing)
- Improvements at the Coleman National Fish Hatchery (partially complete)
- Measures to reduce acute toxicity caused by acid mine drainage and heavy metals (ongoing)
- Various fisheries improvements on Clear Creek (partially complete)
- Flow increases, fish screens, and revised gravel removal practices on Battle Creek (beginning summer 2006, ongoing monitoring)
- Control of gravel mining, improvements of spawning areas, improvements of land management practices in the watershed, and protection and restoration of riparian vegetation along Cottonwood Creek (ongoing)

Sacramento River National Wildlife Refuge

The Sacramento River National Wildlife Refuge (SRNWR) is composed of many units between the cities of Red Bluff and Princeton. The SRNWR along the middle Sacramento River is part of the Sacramento National Wildlife Refuge Complex, consisting of five refuges and three wildlife management areas within the Sacramento Valley. Reaches and subreaches of the river are delineated based generally on transitions in fluvial geomorphic riverine conditions, although county boundaries were considered as well. The middle Sacramento River region between Red Bluff and Colusa includes three units within the Chico Landing Subreach that contain restoration project sites addressed in the *Sacramento River–Chico Landing Subreach Habitat Restoration Draft Environmental Impact Report* (CBDA 2005). In addition, three areas proposed for restoration in this area occur within the larger SRNWR units that were evaluated in the *Environmental Assessment for Proposed Restoration Activities on the Sacramento River National Wildlife Refuge* (USFWS 2001; CBDA 2005).

In June 2005, USFWS issued the *Sacramento River National Wildlife Refuge Final Comprehensive Conservation Plan and Environmental Assessment and Finding of No Significant Impact* (USFWS 2005b) to serve as an integrated management plan for land that it acquires and manages for inclusion in the SRNWR. The SRNWR final comprehensive conservation plan includes goals, objectives, and strategies to guide management of lands within the SRNWR. It also includes assessments of and establishes parameters for “compatible uses,” which are uses that are considered compatible with the primary purposes for which the area was established. Riparian habitat restoration projects are being implemented under cooperative agreements between USFWS and other entities, such as The Nature Conservancy (TNC), in accordance with the SRNWR final comprehensive conservation plan.

Sacramento River Wildlife Area

The Sacramento River Wildlife Area is managed by CDFW and consists of approximately 3,770 acres of important riparian habitat located along a 70-mile reach of the lower Sacramento River. These lands are managed to protect and enhance habitat for wildlife species, and to provide the public with compatible, wildlife-related recreational uses. This management is guided by the *Sacramento River Comprehensive Management Plan* prepared in 2004.

Sacramento River Preservation Trust

The Sacramento River Preservation Trust is a private, nonprofit organization active in environmental education and advocacy to preserve the natural environmental values of the Sacramento River. The trust has participated in various conservation and land acquisition projects, including securing lands for the SRNWR. The group is pursuing designation of a portion of the Sacramento River between Redding and Red Bluff as a national conservation area.

Sacramento River Watershed Program

The Sacramento River Watershed Program is an effort to bring stakeholders together to share information and work together to address water quality and other water-related issues within the Sacramento River watershed. The group is funded congressionally through the U.S. Environmental Protection Agency. The program’s primary goal is “to ensure that current and potential uses of Sacramento River watershed resources are sustained, restored, and where possible, enhanced while promoting the long-term social and economic vitality of the region.” The Sacramento River Watershed Program manages grants for the Sacramento River Toxic Pollutants Control Program; performs extensive water quality monitoring and data collection and management for the watershed; and is instrumental in the study and monitoring of toxic pollutants. Although the program does not implement restoration projects, it is a potential partner for coordinating research and monitoring through consensus-based collaborative partnerships and promoting mutual education among the stakeholders of the Sacramento River watershed.

Sacramento Watersheds Action Group

The Sacramento Watersheds Action Group is a nonprofit corporation that secures funding for, designs, and implements projects that provide watershed restoration, streambank and slope stabilization, erosion control, watershed analysis, and road removal. The Sacramento Watersheds Action Group has successfully worked with local groups, agencies, and organizations to fund and complete restoration projects on the Sacramento River and tributaries downstream from Keswick Dam. Their projects include development of the *Sulphur Creek Watershed Analysis and Action Plan*, the Whiskeytown Reservoir Shoreline Erosion Control Project, the Sulphur Creek Crossing Restoration Project, and the Lower Sulphur Creek Realignment and Riparian Habitat Enhancement Project. The Sacramento Watersheds Action Group is a potential local sponsor for watershed restoration actions in the study area.

Shasta Land Trust

The Shasta Land Trust is a regional, nonprofit organization dedicated to conserving open space, wildlife habitat, and agricultural land. This organization works with public agencies and private landowners and is funded primarily through membership dues and donations. It employs various voluntary programs to protect and conserve valuable lands using conservation easements, land donations, and property acquisitions. The trust is a potential local partner for restoration activities in the Shasta Dam to Red Bluff area.

The Nature Conservancy

TNC is a private, nonprofit organization involved in environmental restoration and conservation throughout the United States and the world. TNC approaches environmental restoration primarily through strategic land acquisition from willing sellers and obtaining conservation easements. Some of the lands are retained by TNC for active restoration, research, or monitoring activities, while others are turned over to government agencies, such as USFWS or CDFW, for long-term management. Lower in the Sacramento River basin, TNC has been instrumental in acquiring and restoring lands in the SRNWR and managing several properties along the Sacramento River. It also has pursued conservation easements on various properties at tributary confluences, including Cottonwood and Battle creeks.

The Trust for Public Land

The Trust for Public Land is a national, nonprofit organization involved in preserving lands with natural, historic, cultural, or recreational value, primarily through conservation real estate. This organization's Western Rivers Program has been involved in conservation efforts along the Sacramento River between Redding and Red Bluff (BLM's Sacramento River Bend Management Area), Battle Creek, Paynes Creek, Inks Creek, and Fenwood Ranch in Shasta County. The group promotes public ownership of conservation lands to ensure public access and enjoyment.

13.3 Environmental Consequences and Mitigation Measures

This section describes the environmental evaluation methods, assumptions, and specific criteria used to determine significance for each resource area, and discusses impacts and proposed mitigation measures. This impacts assessment evaluates the project's compliance with requirements outlined in the *Wildlife Resources Technical Report*. Mitigation measures are presented (as needed) to reduce impacts to a less-than-significant level.

13.3.1 Methods and Assumptions

The following sections describe the methods, processes, procedures, and assumptions used to formulate and conduct the environmental impact analysis.

This analysis of impacts on wildlife resources resulting from implementation of the project alternatives under consideration is based on review of existing documentation that addresses biological resources in or near the primary and extended study areas and on geographic information systems analysis.

Where specific habitat data were not available, suitable habitat data defined by California Wildlife Habitat Relationships (CWHR) were used to determine impacts.

The following assumptions about activity at Shasta Lake and vicinity have been made for the purposes of the impact analysis:

- Activity areas (construction areas for infrastructure and relocation areas) would be completely cleared.
- Cutting/clearing of vegetation would be conducted from late summer through late winter, to the extent feasible.
- Removal of cleared material could occur during the typical breeding season for birds in Shasta County.
- Removal of cleared vegetation would be done using conventional yarding systems and aerial (helicopter) systems.
- With the exception of Arbuckle Flat, no vegetation would be removed along the Pit Arm upstream from Painter Creek.
- No blasting would be required for the mining of materials within the current boundary of Shasta Lake.

For the upper Sacramento River and extended study area, the project has the potential to affect common wildlife and special-status wildlife species through the following impact mechanisms:

- Change in inundated width of the river from spring through fall
- Reduced frequency, duration, or magnitude of intermediate to large flows

- Altered geomorphic processes (e.g., meander, channel avulsion) along rivers
- Altered availability of groundwater
- Altered vegetative communities within the river corridor, including construction-related changes at the potential restoration sites
- Temporary or permanent disturbance of habitat at restoration and gravel augmentation sites
- Mortality of individuals of special-status species at restoration and gravel augmentation sites

Potential effects on the upper Sacramento River and extended study area resulting from these impact mechanisms were assessed for common wildlife and special-status wildlife species associated with riparian and wetland habitats located between Shasta Dam and the Red Bluff Pumping Plant and within the extended study area that may be affected by altered hydrologic flows. It is assumed that construction-related activities at the dam, their effects, and mitigation were considered in the "Shasta Lake and Vicinity" section.

The assessment of potential effects on resources downstream from Keswick Dam was based on review of the output from the SLWRI 2012 Version CalSim-II model. Monthly averages by water year type[1] were reviewed for substantial trends in stage or flow that could alter habitat used by sensitive species or affect species directly. Trend data generated by CalSim-II were considered representative of the potential changes resulting from the project alternatives. A change of less than 2 percent (plus or minus) was considered essentially equivalent to baseline operations and therefore not a substantial change. When monthly average values were changed more than 2 percent, the alternative was considered to result in a substantial change in a species habitat or directly affect the species. Monthly flow results were used to simulate mean daily flows. The use of monthly averages in the evaluation was considered more representative of potential long-term changes in flows than values from the individual months. Results for individual months (e.g., December 1944) were not used in this analysis because the extreme values presented there are sometimes artifacts of model operations and not indicative of how the system would actually operate. See Section 12.3, "Methods and Assumptions," in Chapter 12, "Botanical Resources and Wetlands," for a more detailed discussion of this modeling. The differences in flow regime among the alternatives are described in detail in Chapter 6, "Hydrology, Hydraulics, and Water Management." A more detailed description of the SLWRI 2012 Version CalSim-II model, the modeling

[1] Throughout this document, water year types are defined according to the Sacramento Valley Index Water Year Hydrologic Classification, unless specified otherwise.

methodology used to evaluate this project, and key assumptions are provided in the Modeling Appendix.

The CALFED Ecosystem Restoration Program's Sacramento River Ecological Flows Study (TNC et al. 2008) was also consulted during the evaluation of impacts. This report summarizes the results of a multifaceted analysis conducted to determine the effects of the proposed (18.5-foot) raise of Shasta Dam and the proposed North-of-the-Delta Offstream Storage Reservoir facilities on several focal species, including western pond turtle and bank swallow. CalSim data were also used as inputs for this study; hypothetical flow scenarios were based on historical flows recorded at three locations along the Sacramento River. An appendix to this report is the "Linkages Report" (Stillwater Sciences 2007), which focused the mainstem Sacramento River corridor between Keswick Dam and Colusa. The Linkages Report sought to define how flow characteristics (e.g., magnitude, timing, duration, and frequency) and associated management actions (e.g., gravel augmentation, changes in bank armoring) influence the creation and maintenance of habitats for several native species that occur in the Sacramento River corridor.

The SLWRI 2012 Version CalSim-II model was used to aid in the evaluation of potential impacts of the project alternatives on water-related resources, including riparian habitats along the upper and lower Sacramento River and in the Delta. This computer modeling used historical data about California hydrology to represent the variety of weather and hydrologic patterns, including wet periods and droughts, under which water storage and conveyance facilities would be operated. Two scenarios (base cases) of water demands, storage, and conveyance were used in the modeling runs: 2005 facilities and demands ("existing conditions") and forecasted 2030 demands and reasonably foreseeable projects and facilities ("future conditions"). A modeling run was conducted for each of these base cases combined with each alternative, so that the effects of the No-Action Alternative and other alternatives could be evaluated relative to both existing and future conditions. CalSim-II is a useful tool for this type of comparative analysis. The model is run twice: first to represent a base condition (no action), and second with a specific change (action) to assess the differences in results caused by the input change.

Maximum vs. Likely Area of Impact in Relocation Areas

The relocation areas identified by Reclamation in the 2013 Draft EIS were based on preliminary information, as planning and related engineering designs were incomplete at that time. Habitat impacts disclosed for the relocation areas in the June 2013 Draft EIS assumed complete impact (i.e., 100% loss) within all the relocation areas. Since that time, Reclamation revised the relocation area boundaries by conducting additional planning and design that in many cases reduced the size of the relocation areas. Additionally, Reclamation designed infrastructure and other activities within the revised relocation areas to avoid wetlands and other sensitive resources, and reduce habitat impacts to the extent feasible.

Since final relocation area planning and designs are incomplete, each relocation area contains a “maximum” and “likely” impact area. The maximum area of impact is defined as the maximum area potentially impacted by project activities occurring within the relocation areas, while the likely impact area represents Reclamation’s best estimate of the actual impact (i.e., “most likely”). For the purposes of this Administrative Final EIS, habitat impacts are based on the assumption of complete loss within the likely impact areas. Table 13-8 shows a comparison of the maximum and likely CWHR habitats in the relocation areas.

Table 13-8. Summary of "Maximum and Likely" CWHR Wildlife Habitats in the Relocation Areas

Plant Series	Area (Acres)													
	Main Body		Big Back-bone Arm		Sacramento Arm		McCloud Arm		Squaw Creek Arm		Pit Arm		Total	
	Max	Likely	Max	Likely	Max	Likely	Max	Likely	Max	Likely	Max	Likely	Max	Likely
Annual grassland	4.79	0.40	0.00		26.46	4.95	9.75	0.53	0.84	0.70	0.23	0.01	42.07	6.59
Barren	22.37	12.46	0.00		72.18	11.97	29.71	5.38	11.53	0.00	12.06	2.96	147.86	32.76
Blue oak–foothill pine	1.91	0.01	0.00		0.00	0.00	0.00	0.00	0.00	0.00	7.24	2.35	9.16	2.36
Blue oak woodland	0.00	0.00	0.00		0.00	0.00	3.68	0.00	0.00	0.00	0.92	0.00	4.59	0.00
Closed-cone pine–cypress	0.11	0.05	0.00		41.98	5.65	9.63	2.23	1.94	0.23	12.50	0.94	66.15	9.11
Douglas-fir	0.00	0.00	0.00		0.00	0.00	3.02	0.00	0.00	0.00	0.00	0.00	3.02	0.00
Mixed chaparral	12.65	3.36	0.00		56.11	3.95	26.92	4.11	4.44	1.70	33.98	9.63	134.11	22.77
Montane hardwood	35.81	19.73	0.00		137.77	20.89	148.13	21.64	6.34	0.24	0.13	0.13	328.17	62.63
Montane hardwood–conifer	104.31	24.69	0.00		117.35	19.27	221.40	33.48	29.04	2.61	30.09	6.62	502.19	86.66
Montane riparian	0.34	0.08	0.00		1.35	0.33	3.08	0.25	0.23	0.04	0.02	0.02	5.02	0.72
Ponderosa pine	156.24	79.56	0.00		398.26	96.79	272.10	47.58	43.08	16.04	22.09	0.77	891.77	240.74
Riverine	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Urban	20.66	15.64	0.00		228.60	217.29	0.48	0.27	0.00	0.00	0.57	0.57	250.30	233.76
Total	**359.20**	**155.98**	**0.00**		**1080.05**	**381.09**	**727.90**	**115.47**	**97.44**	**21.56**	**119.83**	**24.00**	**2384.42**	**698.10**

Key:
CWHR = California Wildlife Habitat Relationships
Max = maximum

13.3.2 Criteria for Determining Significance of Effects

Significance criteria used to analyze the potential impacts of the project on wildlife resources include factual and scientific information and regulatory standards of county, State, and Federal agencies, including the State CEQA Guidelines. These criteria have been developed to establish thresholds to determine the significance of impacts pursuant to CEQA Section 15064.7 and should not be confused with a "take" or adverse effect under the ESA. An environmental document prepared to comply with NEPA must consider the context and intensity of the environmental effects that would be caused by, or result from, the proposed action. Under NEPA, the significance of an effect is used solely to determine whether an EIS must be prepared. An EIS must identify reasonable means to "mitigate adverse environmental impacts" (40 E 1502.16(h)). An environmental document prepared to comply with CEQA must identify the potentially significant environmental effects of a proposed project. A "[s]ignificant effect on the environment" means a substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by the project" (CEQA Section 15382). CEQA also requires that the environmental document propose feasible measures to avoid or substantially reduce significant environmental effects (CEQA Section 15126.4(a)).

The following significance criteria were developed based on guidance provided by the State CEQA Guidelines, and consider the context and intensity of the environmental effects as required under NEPA. Impacts of an alternative on wildlife would be significant if project implementation would do any of the following:

- Result in mortality of State-listed or Federally-listed wildlife species, or species that are candidates for listing or proposed for listing

- Have the potential to substantially reduce the habitat of any wildlife species, including those that are listed as endangered or threatened or are candidates or proposed for endangered or threatened status

- Have the potential to cause a wildlife population to drop below self-sustaining levels

- Have a substantial adverse effect, either directly or through habitat modifications, on any non-special-status wildlife species

- Substantially adversely affect, either directly or through habitat modifications, any wildlife species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations or by CDFW or USFWS

- Interfere substantially with the movement of any native resident or migratory wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites

- Conflict with or violate the provisions of an adopted habitat conservation plan, natural community conservation plan, or other approved local, regional, State, or Federal habitat conservation plan relating to the protection of wildlife species

- Conflict with any State or local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance

- Substantially reduce the habitat of a wildlife species, cause a wildlife species to drop below self-sustaining levels, threaten to eliminate an animal community, or substantially reduce the number or restrict the range of an endangered, rare, or threatened species

Significance statements are relative to both existing conditions (2005) and future conditions (2030) unless stated otherwise. Impact conclusions are made using the significance criteria described above and include consideration of the "context" of the action and the "intensity" (severity) of its effects in accordance with NEPA guidance (40 CFR 1508.27).

13.3.3 Topics Eliminated from Further Consideration

No topics related to wildlife resources that are included in the significance criteria listed above were eliminated from further consideration. All relevant topics are analyzed below.

13.3.4 Direct and Indirect Effects

This section identifies how wildlife could be affected by the project. The project could affect wildlife by doing any of the following:

- Inundating existing habitat around Shasta Lake and causing habitat loss

- Causing construction-related effects at Shasta Dam and around Shasta Lake

- Altering flow regimes downstream from Shasta Lake and downstream from other reservoirs with altered operations

- Increasing water supply reliability, which in turn could contribute to human population growth or changes in agricultural land uses in the CVP and SWP service areas

By altering storage and reservoir operations, the project would change flow regimes in downstream waterways. In turn, these alterations to the flow regime could affect wildlife, particularly by affecting their riparian and wetland habitats along several waterways.

No-Action Alternative

Under the No-Action Alternative, Reclamation would not pursue an action to enlarge Shasta Dam. No new facilities would be constructed at Shasta Dam and no facilities around Shasta Lake would be relocated to accommodate higher lake levels; thus, there would be no construction-related impacts. In addition, releases from Shasta Dam or other CVP reservoirs would not change as a result of a Shasta Dam enlargement. Reasonably foreseeable projects identified elsewhere in this EIS, however, would occur and have effects on wildlife but those effects are unknown or largely speculative for many such projects, and therefore are not addressed in detail below.

Shasta Lake and Vicinity

Impact Wild-1 (No-Action): Impacts on Habitat for the Shasta Salamander No direct take of the Shasta salamander or loss of its habitat would occur because the project would not be constructed. No impact would occur. Mitigation is not required for the No-Action Alternative.

Impact Wild-2 (No-Action): Impacts on the Foothill Yellow-Legged Frog and Tailed Frog and Their Habitat No impacts or loss of habitat for the foothill yellow-legged frog or tailed frog would occur because the project would not be constructed. No impact would occur. Mitigation is not required for the No-Action Alternative.

Impact Wild-3 (No-Action): Impacts on the Northwestern Pond Turtle and Its Habitat No direct take or decrease of habitat quality for the northwestern pond turtle would occur because the project would not be constructed. No impact would occur. Mitigation is not required for the No-Action Alternative.

Impact Wild-4 (No-Action): Impacts on the American Peregrine Falcon No impact on the American peregrine falcon would occur because the project would not be constructed. No impact would occur. Mitigation is not required for the No-Action Alternative.

Impact Wild-5 (No-Action): Impacts on Habitat for the Bald Eagle No take of loss of habitat for the bald eagle would occur because the project would not be constructed. No impact would occur. Mitigation is not required for the No-Action Alternative.

Impact Wild-6 (No-Action): Impacts on Dispersal Habitat for the Northern Spotted Owl No take or loss of nesting and foraging habitat for the northern spotted owl would occur because the project would not be constructed. No impact would occur. Mitigation is not required for the No-Action Alternative.

Impact Wild-7 (No-Action): Impacts on the Purple Martin and Its Nesting Habitat No impacts or loss of nesting habitat for the purple martin would occur because the project would not be constructed. No impact would occur. Mitigation is not required for the No-Action Alternative.

Impact Wild-8 (No-Action): Impacts on the Willow Flycatcher, Vaux's Swift, Yellow Warbler, and Yellow-Breasted Chat and Their Foraging and Nesting Habitat No impacts or loss of foraging and nesting habitat for the willow flycatcher, Vaux's swift, yellow warbler, and yellow-breasted chat would occur because the project would not be constructed. No impact would occur. Mitigation is not required for the No-Action Alternative.

Impact Wild-9 (No-Action): Impacts on the Long-Eared Owl, Northern Goshawk, Cooper's Hawk, Great Blue Heron, and Osprey and Their Foraging and Nesting Habitat No impact or loss of foraging and nesting habitat for the long-eared owl, northern goshawk, Cooper's hawk, great blue heron, and osprey would occur because the project would not be constructed. No impact would occur. Mitigation is not required for the No-Action Alternative.

Impact Wild-10 (No-Action): Impacts on Habitat for the Pacific Fisher No take or loss of habitat for the Pacific fisher would occur because the project would not be constructed. No impact would occur. Mitigation is not required for the No-Action Alternative.

Impact Wild-11 (No-Action): Impacts on Special-Status Bats (Pallid Bat, Spotted Bat, Western Red Bat, Western Mastiff Bat, Townsend's Big-Eared Bat, Long-Eared Myotis, Yuma Myotis, and Fringed myotis), the American Marten, and Ringtail and Their Habitat No impact or loss of habitat for special-status bats (the pallid bat, spotted bat, western red bat, western mastiff bat, Townsend's big-eared bat, long-eared myotis, Yuma Myotis, and fringed myotis), the American marten, and ringtail would occur because the project would not be constructed. No impact would occur. Mitigation is not required for the No-Action Alternative.

Impact Wild-12 (No-Action): Impacts on Special-Status Terrestrial Mollusks (Church's Sideband, Shasta Sideband, Wintu Sideband, Oregon Shoulderband, Shasta Chaparral, and Shasta Hesperian) and Their Habitat No impact or loss of habitat for special-status terrestrial mollusks (Church's sideband, Shasta sideband, Wintu sideband, Oregon shoulderband, Shasta chaparral, and Shasta hesperian) would occur because the project would not be constructed. No impact would occur. Mitigation is not required for the No-Action Alternative.

Impact Wild-13 (No-Action): Permanent Loss of Wildlife Habitat and Western Bumble Bee Habitat No permanent loss of habitat would occur because the project would not be constructed. No impact would occur. Mitigation is not required for the No-Action Alternative.

Impact Wild-14 (No-Action): Impacts on Other Birds of Prey (e.g., red-tailed hawk and Red-shouldered Hawk) and Migratory Bird Species (e.g., American Robin, Anna's Hummingbird) and their Foraging and Nesting Habitat No impact or loss of foraging and nesting habitat for other birds of prey and migratory bird species would occur because the project would not be constructed. No impact would occur. Mitigation is not required for the No-Action Alternative.

Impact Wild-15 (No-Action): Impacts on Critical Deer Winter and Fawning Range No loss of deer winter and fawning range would occur because the project would not be constructed. No impact would occur. Mitigation is not required for the No-Action Alternative.

Impact Wild-16 (No-Action): Impacts on California Red-Legged Frog No loss of California red-legged frog habitat would occur because the project would not be constructed. No impact would occur. Mitigation is not required for the No-Action Alternative.

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact Wild-17 (No-Action): Impacts on Riparian-Associated Special-Status Wildlife Resulting from Modifications to the Existing Flow Regime in the Primary Study Area Effects on riparian vegetation in the upper Sacramento River area from continuing the existing dam operation under the No-Action Alternative would not have a substantial adverse effect on special-status wildlife. This impact would be less than significant.

Implementing the No-Action Alternative would not result in changes to existing facilities or reservoir operations. The No-Action Alternative would continue to alter the structure and species composition of riparian vegetation resulting from continued operation of the existing Shasta Dam, as described in Chapter 12, “Botanical Resources and Wetlands.” Operation of the dam has decreased early successional riparian communities and increased the extent of mid-successional riparian communities. Although early and mid-successional riparian vegetation provides different habitat values and some shifts in species use may occur, implementing the No-Action Alternative would not have a substantial adverse effect on special-status wildlife associated with riparian vegetation, nor would it be likely to cause a population to be eliminated. Therefore, this impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Impact Wild-18 (No-Action): Impacts on Bank Swallow in the Primary Study Area Resulting from Modifications of Geomorphic Processes Future conditions for bank swallows are not expected to differ substantially from existing conditions because only very small changes in flows greater than 30,000 cfs (a magnitude that strongly affects bank erosion and meander migration) would occur along the upper Sacramento River (see Section 12.3, “Environmental Consequences and Mitigation Measures” in Chapter 12, “Botanical Resources and Wetlands” [reference Impact Bot-7 (No-Action)]) and would result in no change to the ongoing geomorphic processes in the upper Sacramento River (see Section 11.3, “Environmental Consequences and Mitigation Measures ,” in Chapter 11, “Fisheries and Aquatic Ecosystems” [reference Impact Aqua-14 (No-Action)]).

Because water from high-flow events would be captured and stored and would be metered out in an even fashion, dam operations under the No-Action Alternative would continue with only very small changes in flows and no changes to the ongoing geomorphic processes along the upper Sacramento River. Therefore, future conditions for bank swallows are not expected to differ substantially from existing conditions. Therefore, this impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Impact Wild-19 (No-Action): Disturbance or Removal of Vernal Pool Habitat for Special-Status Wildlife from Changes in Flow Regime The No-Action Alternative would not alter vernal pool hydrology or affect vernal pool–associated wildlife in the upper Sacramento River area. Because the No-Action Alternative would not affect this resource, no impact would occur. Mitigation is not required for the No-Action Alternative.

Impact Wild-20 (No-Action): Consistency with Local and Regional Plans with Goals of Promoting Riparian Habitat in the Primary Study Area Riparian habitat conditions along the upper Sacramento River under the No-Action Alternative would not differ from baseline conditions. The No-Action Alternative would not conflict with existing plans promoting conservation, protection, and restoration of riparian habitat. Local plans and policies that influence riparian management would remain in place and continue to be locally enforced. Because conditions would not differ from the existing baseline, no impact would occur. Mitigation is not required for the No-Action Alternative.

Impact Wild-21 (No-Action): Impacts on Riparian-Associated Special-Status Wildlife Resulting from the Gravel Augmentation Program Under the No-Action Alternative, the gravel augmentation program would not be implemented. No impact would occur. Mitigation is not required for the No-Action Alternative.

Impact Wild-22 (No-Action): Impacts on Riparian-Associated Special-Status Wildlife Species Resulting from Restoration Projects Under the No-Action Alternative, none of the restoration work described in Chapter 2, “Alternatives,” would be conducted downstream from Shasta Dam. Thus, special-status wildlife species found in riparian habitat would not be affected. No impact would occur. Mitigation is not required for the No-Action Alternative.

Lower Sacramento River and Delta

Impact Wild-23 (No-Action): Impacts on Riparian-Associated and Aquatic Special-Status Wildlife Resulting from Modifications to Existing Flow Regimes in the Lower Sacramento River and Delta Effects on riparian vegetation in the lower Sacramento River and Delta areas from continuing the existing dam operation under the No-Action Alternative would not have a substantial adverse effect on special-status wildlife. This impact would be less than significant.

This impact would be similar to Impact Wild-17 (No-Action) for the primary study area. The No-Action Alternative would continue to alter the structure and species composition of riparian habitat along the lower Sacramento River and into the Delta resulting from continued operation of Shasta Dam. Dam operation, which has led to a decrease in early successional riparian communities and an increase in the extent of mid-successional riparian communities, would continue under the No-Action Alternative. Thus, the No-Action Alternative would affect habitats used by special-status wildlife species because early- and mid-successional riparian vegetation provides different habitat values. However, this change is expected to be small and is not likely to have a substantial adverse effect on special-status species, nor would it be likely to cause a population to be eliminated. Therefore, this impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Impact Wild-24 (No-Action): Impacts on Bank Swallow Along the Lower Sacramento River Resulting from Modifications of Geomorphic Processes
Future conditions for bank swallows along the lower Sacramento River are not expected to differ substantially from existing conditions because only very small changes in flows greater than 30,000 cfs (a magnitude that strongly affects bank erosion and meander migration) would occur along the uppermost portion of the lower Sacramento River (see Section 12.3, “Environmental Consequences and Mitigation Measures” in Chapter 12, “Botanical Resources and Wetlands” [reference Impact Bot-14 (No-Action)]) and no project-related alteration of river flows would occur in the lower Sacramento River (see Section 11.3, “Environmental Consequences and Mitigation Measures” in Chapter 11, “Fisheries and Aquatic Ecosystems” [reference Lower Sacramento River, Tributaries, Delta, and Trinity River subsection under No-Action Alternative)]). This impact would be less than significant.

This impact would be similar to Impact Wild-18 (No-Action) for the primary study area. Dam operations under the No-Action Alternative would continue with only very small changes in flows and the ongoing geomorphic processes along the lower Sacramento River.. Although ongoing dam operations tend to result in the loss of eroding banks during winter flood flows, which could limit the formation of suitable nesting habitat for bank swallow, the future conditions for bank swallows are not expected to differ substantially from existing conditions. Therefore, this impact would be less than significant. Mitigation is not required for the No-Action Alternative.

Impact Wild-25 (No-Action): Disturbance or Removal of Vernal Pool Habitat for Special-Status Wildlife Along the Lower Sacramento River and in the Delta from Changes in Flow Regime of the Sacramento River and Affected Tributaries, and Changes in Seasonal Water Availability The No-Action Alternative would not affect the hydrology of vernal pools or have an adverse effect on vernal pool–associated wildlife species in the lower Sacramento River and Delta area. Because the No-Action Alternative would not affect this resource, no impact would occur. Mitigation is not required for the No-Action Alternative.

Impact Wild-26 (No-Action): Consistency with Local and Regional Plans with Goals of Promoting Riparian Habitat along the Lower Sacramento River and in the Delta Riparian habitat conditions along the lower Sacramento River or in the Delta would not differ from baseline under the No-Action Alternative. The No-Action Alternative would not conflict with existing plans promoting conservation, protection, and restoration of riparian habitat along the lower Sacramento River and in the Delta. Because conditions would not differ from the existing baseline, no impact would occur. Mitigation is not required for the No-Action Alternative.

CVP/SWP Service Areas

Impact Wild-27 (No-Action): Impacts on Riparian-Associated or Aquatic Special-Status Wildlife in the CVP/SWP Service Areas Resulting from Modifications to Existing Flow Regimes Changes to CVP and SWP water deliveries that would occur while the existing dam operation continues under the No-Action Alternative would not have a substantial adverse effect on special-status wildlife. This impact would be less than significant.

This impact would be similar to Impact Wild-17 (No-Action) for the primary study area and Impact Wild-21 (No-Action) for the lower Sacramento River and Delta. Although Shasta Dam would not be altered under the No-Action Alternative, CVP and SWP water storage, conveyance, and deliveries to the CVP and SWP service areas could change because of several reasonably foreseeable projects that could occur with or without enlarging Shasta Dam. CVP and SWP deliveries could increase or decrease based on any number of factors between now and 2030. Given environmental regulations to protect sensitive habitats and species, these changes are not likely to have a substantial adverse effect on special-status species, nor would they be likely to cause a population to be eliminated. For these reasons, this impact would be less than significant. Mitigation is not required for the No-Action Alternative.

CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

CP1 focuses on increasing water supply reliability while contributing to increased survival of anadromous fish, actions that are consistent with the 2000 CALFED Programmatic ROD. In addition to the common features above, CP1 primarily involves raising Shasta Dam 6.5 feet, an elevation change that would increase the reservoir's full pool by 8.5 feet and would enlarge the total storage space in the reservoir by 256,000 acre-feet. Under this plan, Shasta Dam operational guidelines would continue unchanged, with the additional storage retained for water supply reliability and increased anadromous fish survival.

Shasta Lake and Vicinity

Impact Wild-1 (CP1): Take and Loss of Habitat for the Shasta Salamander
Ground-disturbing activities and vegetation removal associated with dam construction activities, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas could result in direct take of the Shasta salamander, a State-listed species, USFS sensitive species, S&M species, MSCS-covered species, and BLM sensitive species. Additionally, the raising of Shasta Dam would result in the inundation of habitat for this species. This impact would be significant.

Collectively, 38 Shasta salamander occurrences are known within the impoundment and relocation areas surveyed by Reclamation. Shasta salamanders have been found or are known to occur in nearly every CWHR habitat present along each arm. These known locations occur in CWHR habitats characterized by the presence (limestone habitat) or absence (nonlimestone habitat) of limestone substrate. Within the impoundment area, the presence of the Shasta salamander is presumed in all CHWR habitats, except “non-habitat” barren areas (e.g., paved parking lots, boat ramps). For the purposes of this impact analysis, all CWHR habitats in the impoundment and relocation areas are stratified as limestone or nonlimestone habitat.

Inundation resulting from a 6.5-foot dam raise would result in a loss of approximately 8 acres of limestone habitat and 1,187 acres of nonlimestone habitat. Impacts on limestone and nonlimestone habitats in the impoundment area are summarized in Table 13-9.

Table 13-9. Impacts on Suitable Habitat for the Shasta Salamander in the Impoundment Area (6.5-Foot Dam Raise)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Limestone	0.00	0.82	0.00	5.43	0.00	1.50	7.75
Nonlimestone	222.31	42.48	343.21	199.40	121.55	258.72	1187.67
Total	222.31	43.30	343.21	204.83	121.55	260.22	1195.42

Note:
[1] Acreage values are approximate.

Direct mortality of Shasta salamanders would occur in areas of suitable habitat where complete vegetation clearing is implemented and/or mechanized construction equipment is employed if these activities occur during the wet season when salamanders are on the surface. Construction activities in relocation areas would result in a loss of up to approximately 1 acre of limestone habitat and 424 acres of nonlimestone habitat. This impact would be significant. Impacts on limestone and nonlimestone habitat by CWHR type providing suitable habitat in the relocation areas are summarized in Table 13-10.

Mortality of individuals could occur over multiple years during project implementation if ground-disturbing activities are conducted during the wet season. This impact would be significant. Mitigation for this impact is proposed in Section 13.3.5.

Table 13-10. Impacts on Suitable Habitat for the Shasta Salamander in Relocation Areas

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Limestone	0.00	0.00	0.00	0.96	0.00	0.00	0.96
Nonlimestone	127.48	0.00	146.88	108.34	20.86	20.45	424.03
Total	127.48	0.00	146.88	109.30	20.86	22.09	424.99

Note:
[1] Acreage values are approximate.

Impact Wild-2 (CP1): Impact on the Foothill Yellow-Legged Frog and Tailed Frog and Their Habitat Ground-disturbing activities and vegetation removal associated with dam construction activities, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas could result in direct take of the foothill yellow-legged frog, a California species of special concern, a USFS sensitive species, an MSCS-covered species, and a BLM sensitive species, and the tailed frog, a California species of special concern. Operation of equipment in or adjacent to riverine or riparian habitat would result in direct impacts on these species. In addition, inundation caused by the raising of Shasta Dam would result in the conversion of suitable riverine and riparian habitat to unsuitable lacustrine habitat. These impacts would be potentially significant.

Foothill yellow-legged frogs occur in many perennial streams within the impoundment area. They have been found in streams on all arms and the main body of the lake. Tailed frogs have not been found during surveys, but there are known occurrences in the McCloud and upper Sacramento arms. CWHR habitat types, montane riparian and riverine, are suitable habitat where these species might occur.

Individual foothill yellow-legged frogs and tailed frogs will not be affected by the inundation caused by the raise of the dam. These animals will be able to swim upstream to suitable habitat.

Although frogs may move out of harm’s way, direct take of foothill yellow-legged frog and tailed frog could also occur as a result of project-associated construction activities in or near suitable aquatic habitat. Potential construction impacts include mortality of individuals because of equipment use and vehicle traffic within suitable aquatic and upland habitat. The potential for direct take would be temporary, occurring only during project construction. Project implementation could result in the degradation of suitable aquatic habitat because of increased erosion, sedimentation, or accidental fuel leaks and spills. These impacts would be potentially significant.

Mortality of individuals could occur over multiple years during project implementation if construction activities are conducted in perennial streams. This impact would be potentially significant.

Implementation of a 6.5-foot dam raise would result in inundation of approximately 35 acres of habitat for the foothill yellow-legged frog and tailed frog. Approximately 0.72 acre of suitable habitat would be lost because of vegetation removal associated with dam construction and construction in the relocation areas. Summaries of suitable habitat loss by arm are presented in Table 13-11. Mitigation for this impact is proposed in Section 13.3.5.

Table 13-11. Impacts on Suitable Habitat for the Foothill Yellow-Legged and Tailed Frog in the Impoundment Area and Relocation Areas (6.5-Foot Dam Raise)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Impoundment Area							
Montane riparian	1.54	2.48	15.92	4.60	0.58	2.59	27.71
Riverine	0.00	0.35	2.30	3.81	0.59	0.00	7.04
Total	1.54	2.83	18.22	8.41	1.17	2.59	34.75
Relocation Areas							
Montane riparian	0.08	0.00	0.33	0.25	0.04	0.02	0.72
Total	0.08	0.00	0.33	0.25	0.23	0.02	0.72

Note:
[1] Acreage values are approximate.

Impact Wild-3 (CP1): Impact on the Northwestern Pond Turtle and Its Habitat Ground-disturbing activities and vegetation removal associated with dam construction activities, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas could result in direct take of the northwestern pond turtle, a California species of special concern, a USFS sensitive species, and an MSCS-covered species. These impacts would be potentially significant.

Individual northwestern pond turtles will not be impacted by the inundation caused by the raise of the dam. Lacustrine and riverine are suitable habitats for the northwestern pond turtle.

The northwestern pond turtle occurs throughout the perimeter of the impoundment area. In addition to aquatic habitats, this species uses upland habitats for nesting and overwintering. Nests are generally located on south-facing slopes of less than 60 degrees averaging 200 meters (660 feet) from an aquatic site (CDFG 1994). Thus, loss of upland habitats adjacent to suitable aquatic habitat (within approximately 660 feet) could adversely affect this species.

Direct take of northwestern pond turtle eggs or juveniles could occur during the first inundation of habitat above 1,070 feet above msl. Turtles may lay eggs in suitable habitat that subsequently becomes inundated, resulting in the death of the eggs or overwintering juveniles. In addition, inundation caused by the raising of Shasta Dam would result in the conversion of suitable habitat to unsuitable lacustrine habitat. These impacts would be potentially significant.

Direct take of northwestern pond turtles could also occur as a result of project-associated construction activities in or near suitable aquatic and upland habitat. Potential construction impacts include mortality of individuals because of equipment use and vehicle traffic within suitable aquatic and upland habitat. In addition, project implementation could result in the degradation of suitable aquatic habitat because of increased erosion, sedimentation, or accidental fuel leaks and spills. Additionally, it is assumed that all vegetation will be removed within the relocation areas.

Mortality of individuals could occur over multiple years during project implementation if construction activities are conducted in suitable aquatic and upland habitat. This impact would be potentially significant.

Implementation of a 6.5-foot raise of the dam would result in conversion of approximately 35 acres of suitable habitat for the northwestern pond turtle. Approximately 7 acres of riverine habitat would be converted to lacustrine habitat. Because there are equally valuable components lost or gained in either habitat, the quality of the habitat would not be compromised. However, maximum lake elevation is infrequent and would not benefit the species throughout the remainder of the year. Thus, the conversion of suitable habitats to lacustrine habitat remains an impact on northwestern pond turtle habitat.

Approximately 0.72 acre of suitable aquatic habitat would be lost because of vegetation removal associated with dam construction and construction of the relocation areas. Summaries of suitable habitat lost by arm are presented in Table 13-12.

Table 13-12. Impacts on Suitable Habitat for the Northwestern Pond Turtle in the Impoundment Area and Relocation Areas (6.5-Foot Dam Raise)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Impoundment Area							
Montane riparian	1.54	2.48	15.92	4.60	0.58	2.59	27.71
Riverine	0.00	0.35	2.30	3.81	0.59	0.00	7.04
Total	1.54	2.83	18.22	8.41	1.17	2.59	34.75
Relocation Areas							
Montane riparian	0.08	0.00	0.33	0.25	0.04	0.02	0.72
Total	0.08	0.00	0.33	0.25	0.04	0.02	0.72

Note:
[1]Acreage values are approximate.

Impact Wild-4 (CP1): Impact on the American Peregrine Falcon Construction activities and vegetation removal associated with dam construction activities, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas during the nesting season could result in the incidental loss of fertile eggs or nestlings or otherwise lead to the abandonment of nests of American peregrine falcons, a State fully protected and MSCS-covered species. This impact would be potentially significant.

Cliffs within the Shasta Lake and vicinity portion of the primary study area provide suitable nesting habitat for the peregrine falcon. Overstory and complete vegetation removal is expected to occur within the impoundment area in suitable cliff habitat. Thus, overstory vegetation removal occurring in or near suitable cliff habitat during the nesting season could result in the incidental loss of fertile eggs or nestlings or otherwise lead to the abandonment of nests. Additionally, because of the steep terrain, trees would be yarded by helicopter. Noise generated by chainsaws and helicopter yarding could cause the abandonment of nests, resulting in the incidental loss of fertile eggs or nestlings. This impact would be potentially significant.

No known eyries would be inundated by a 6.5-foot raise in lake elevation; however, 8.5 vertical feet (full pool) of cliff habitat would be inundated. Peregrine falcons nest on sheer cliffs ranging in height from 75 to 2,000 feet. Eyries are generally located between 40 and 80 percent of total cliff height (Pagel 1992). Based on the large area required for suitable nesting habitat for peregrine falcons, impacts on suitable cliff habitat for nesting would be less than significant. The conversion of uplands to lacustrine habitat would not adversely affect foraging habitat for the species because they frequently forage over water.

Impacts on nesting American peregrine falcons could occur over multiple years during project implementation if construction activities were conducted in or adjacent to active nests. This impact would be potentially significant. Construction or vegetation removal related to relocation areas is not anticipated to occur in suitable cliff habitat. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-5 (CP1): Take and Loss of Habitat for the Bald Eagle Ground-disturbing activities and vegetation removal associated with dam construction activities, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas in addition to inundation caused by the raising of Shasta Dam during the nesting season would result in the loss of nest and perch trees used by the bald eagle, a State-listed, fully protected, and USFS sensitive species, MSCS-covered species, and a BLM sensitive species. This impact would be significant.

Typically, 24 to 28 pairs nest in the vicinity of Shasta Lake. Vegetation removal within the impoundment area could result in the incidental loss of fertile eggs or nestlings or otherwise lead to the abandonment of bald eagle nests. Noise generated by vegetation removal, such as noise caused by helicopter yarding and chainsaw use, could also lead to nest abandonment, resulting in the incidental loss of fertile eggs or nestlings. The loss of nesting and foraging habitat would be a potentially significant impact.

Three known bald eagle nest trees would be affected by inundation with a 6.5-foot dam raise. When inundation occurs, nest trees within the impoundment area would die. Because peak inundation generally occurs in late April or early June, nest trees would be flooded toward the end of the nesting season. If eagles were nesting in these trees, it would be likely that young would fledge before the nest tree died from the effects of inundation. Because of inundation timing, it is not likely that individuals would be affected. Because bald eagles generally use the same nest for multiple years, the loss of nest trees would be a significant impact.

Inundation could also affect erosion and bank stability, which could affect nest trees that are in close proximity to the impoundment area. This would be a potentially significant impact.

The increase in lake elevation may increase access to eagle nests by recreational boaters. The increase in noise and human disturbance may lead to nest abandonment and the incidental loss of fertile eggs or young. Additionally, habitat inundated within the impoundment area would result in a loss of roosting and potential nest trees. This impact would be significant.

One eagle nest is located in the relocation area at Gregory Beach. Removal of nest trees would be a potentially significant impact. Additionally, one nest occurs near the Bailey Cove trail, which could be impacted by noise generated by vegetation removal activities. Vegetation removal and additional construction activities in the relocation areas would result in the same impacts on nesting bald eagles as described for vegetation removal activities proposed in the impoundment areas. This impact would be significant.

Impacts on nesting bald eagles could occur over multiple years during project implementation if construction activities are conducted at or adjacent to active nest sites. This impact would be significant.

Dam construction, vegetation removal, and inundation resulting from a 6.5-foot dam raise would result in a loss of approximately 979 acres of bald eagle nesting and roosting habitat in the impoundment area and 393 acres in the relocation areas. Potential nest and roost trees occur in blue oak woodland, blue oak–foothill pine, Douglas-fir, Klamath mixed conifer, montane hardwood, montane hardwood–conifer, montane riparian, and ponderosa pine habitats and are typically found in trees with diameters greater than 24 inches. Impacts on suitable bald eagle habitat by CWHR type in the impoundment area and relocation areas are summarized in Table 13-13.

Mitigation for this impact is proposed in Section 13.3.5.

Table 13-13. Impacts on Suitable Habitat for the Bald Eagle in the Impoundment Area and Relocation Areas (6.5-Foot Dam Raise)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Impoundment Area							
Blue oak woodland	0.00	0.00	0.00	0.00	0.00	2.21	2.21
Blue oak–foothill pine	4.96	0.00	0.00	0.00	1.40	16.35	22.71
Douglas-fir	0.00	0.00	0.00	0.01	0.00	0.00	0.01
Klamath mixed conifer	0.00	0.00	0.00	0.00	0.00	5.51	5.51
Montane hardwood	39.08	18.13	86.75	34.61	9.44	39.49	227.49
Montane hardwood–conifer	34.65	0.50	69.23	66.31	55.70	89.81	316.21
Montane riparian	1.54	2.48	15.92	4.60	0.58	2.59	27.71
Ponderosa pine	108.93	15.36	84.75	81.20	25.06	61.89	377.19
Total	189.17	36.46	256.65	186.73	92.18	217.86	979.05

Table 13-13. Impacts on Suitable Habitat for the Bald Eagle in the Impoundment Area and Relocation Areas (6.5-Foot Dam Raise) (contd.)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	Mc Cloud Arm	Squaw Creek Arm	Pit Arm	Total
Relocation Areas							
Blue oak–foothill pine	0.01	0.00	0.00	0.00	0.00	2.34	2.35
Montane hardwood	19.73	0.00	20.89	21.64	0.24	0.13	62.63
Montane hardwood–conifer	24.69	0.00	19.27	33.48	2.61	6.62	86.66
Montane riparian	0.08	0.00	0.33	0.25	0.04	0.02	0.72
Ponderosa pine	79.56	0.00	96.79	47.58	16.04	0.77	240.74
Total	124.07	0.00	137.28	102.95	18.93	9.88	393.11

Note:
[1] Acreage values are approximate.

Impact Wild-6 (CP1): Loss of Dispersal Habitat for the Northern Spotted Owl
Construction activities and vegetation removal associated with the dam construction activities, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas would result in the loss of northern spotted owl dispersal habitat, a species Federally listed as threatened and an MSCS-covered species. This impact would be potentially significant.

Reclamation conducted a habitat analysis within the Shasta Lake and vicinity portion of the primary study area to determine potential project impacts to northern spotted owl habitat. The analysis was performed using a GIS-based habitat model developed by the USFS northern California forests in coordination with the USFWS. The USFS developed this model using the Existing Vegetation data (EVEG) created by the USFS Remote Sensing Lab. The habitat model is referred to as NSO EVEG and defines potential northern spotted owl habitat by incorporating the vegetation data and specific northern spotted owl habitat attributes, including overstory canopy cover, proportion of conifer and hardwood trees, average tree diameter, vegetation alliance, elevation, geographic location, and ecologic setting. Using the vegetation data and northern spotted owl habitat attributes, the NSO EVEG model designates polygons as potential northern spotted owl dispersal, nesting/roosting, and foraging habitats, or non-habitat. Reclamation queried the NSO EVEG model within the Shasta Lake and vicinity portion of the primary study area to determine the amount and location(s) of potential northern spotted owl dispersal, nesting/roosting, and foraging habitats.

Dam construction, vegetation removal, and construction in the relocation areas, and inundation resulting from a 6.5-foot dam raise would result in a loss of northern spotted owl dispersal habitat, including approximately 437 acres in the impoundment area and 340 acres in the relocation areas. Impacts on potential northern spotted owl dispersal habitat in the impoundment area and relocation areas are summarized in Table 13-14. No nesting/roosting or foraging habitat occurs in the Shasta Lake and vicinity portion of the primary study area; therefore, no impacts to these habitats would occur.

Mitigation for this impact is proposed in Section 13.3.5.

Table 13-14. Impacts on Dispersal Habitat for the Northern Spotted Owl in the Impoundment Area and Relocation Areas (6.5-Foot Dam Raise)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Impoundment Area							
Dispersal	66.10	7.12	103.16	107.22	54.25	100.05	437.89
Foraging	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nesting/roosting	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	66.10	7.12	103.16	107.22	54.25	100.05	437.89
Relocation Areas							
Dispersal	70.00	0.00	167.27	86.24	8.08	9.34	340.92
Foraging	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nesting/roosting	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	70.00	0.00	167.27	86.24	8.08	9.34	340.92

Note:
[1] Acreage values are approximate.

Impact Wild-7 (CP1): Impact on the Purple Martin and Its Nesting Habitat
Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas during the nesting season could result in the incidental loss of fertile eggs or nestlings or otherwise lead to the abandonment of nests of purple martins, a California species of special concern. In addition, inundation caused by the raising of Shasta Dam would result in the loss of available nest trees. This impact would be significant.

Shasta Lake supports the largest and one of only a few known purple martin breeding locations in interior northern California. Between 18 and 42 nesting pairs occur at Shasta Lake based on monitoring performed by Reclamation since 2007. The purple martin nest sites are found in flooded snags located in the existing reservoir and adjacent uplands, and occur from the vicinity of Jones Valley east up the Pit Arm. Overstory vegetation removal is proposed for the relocation of the Clikapudi Trail (Jones Valley area). With the exception of Arbuckle Flat, no vegetation removal is proposed on the Pit Arm east of the Painter Creek inlet.

Inundation of the impoundment area would result in the loss of nest trees in the lake and several known upland nest trees. Each nest tree contains several potential nest cavities at various heights above the water. Therefore, with an increase in inundation levels, fewer potential nest cavities could be available from year to year. Loss of nest trees may be temporary, as trees that are inundated would die, become snags, and provide potential nest sites. The temporal loss of nesting snags would be a significant impact.

Overstory vegetation removal is proposed for the relocation of the Clikapudi Trail. This could include removal of snags that are actively used for nesting or could provide nesting habitat for purple martin. Construction activities such as tree removal, site grading, and excavation and vegetation removal, including noise caused by helicopter yarding and chainsaw use during the nesting season, could result in the incidental loss of fertile eggs or nestlings or otherwise lead to nest abandonment. Loss of fertile eggs or nesting adults, or any activities resulting in nest abandonment, would be a significant impact.

Impacts on nesting purple martins could occur over multiple years during project implementation if construction activities were conducted at or adjacent to active nest sites. This impact would be significant.

Purple martins forage high in the air and above the tree canopy. Conversion of upland habitats to lacustrine habitat may have an effect on foraging habitat due to the loss of insect-producing vegetation; however, insect production also occurs in lacustrine habitats. Therefore, there would be an insignificant impact on foraging habitat.

Mitigation for all impacts to purple martin is proposed in Section 13.3.5.

Impact Wild-8 (CP1): Impacts on the Willow Flycatcher, Vaux's Swift, Yellow Warbler, and Yellow-Breasted Chat and Their Foraging and Nesting Habitat
Construction activities and vegetation removal associated with dam construction activities, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas during the nesting season could result in the incidental loss of fertile eggs or nestlings or otherwise lead to the abandonment of nests of the willow flycatcher, a State-listed endangered, USFS sensitive, and MSCS-covered species; the Vaux's swift, a California species of special concern; and the yellow warbler and yellow-breasted chat, both California species of special concern and MSCS-covered species. In addition, the raising of Shasta Dam would result in the loss of habitat, including nesting habitat, for these species. This impact would be potentially significant.

Vegetation removal within the impoundment area during the nesting season could result in the incidental loss of fertile eggs or nestlings or otherwise lead to the abandonment of nests of these species. Noise generated by vegetation removal activities, including helicopter yarding and chainsaw use, could also lead to nest abandonment, resulting in the incidental loss of fertile eggs or nestlings. This impact would be potentially significant. The loss of nesting and foraging habitat would be a potentially significant impact.

A 6.5-foot dam raise would result in inundation of nesting and foraging habitat for these species. Understory vegetation in 15 percent of the impoundment area would be removed before inundation; the remainder would not survive the inundation. Therefore, inundation of the impoundment area would reduce the nesting habitat for these species. If removal were completed outside of the breeding season, nesting would not be affected. However, 63 percent of vegetation would not be removed and would be inundated. Because peak inundation generally occurs in late April through early June, active nests established before and while lake levels were rising could be flooded. The loss of nests and nesting and foraging habitat from inundation would be a potentially significant impact.

Construction activities, such as tree removal, site grading, excavation, and vegetation removal, at the dam and in relocation areas during the nesting season could result in the incidental loss of fertile eggs or nestlings or otherwise lead to nest abandonment. Additionally, noise generated by project construction activities and vegetation removal, including helicopter yarding and chainsaw use, could lead to nest abandonment resulting in the incidental loss of fertile eggs or nestlings. Vegetation removal in relocation areas would also result in a loss of nesting and foraging habitat. This would be a potentially significant impact.

Impacts on these species could occur over multiple years during project implementation if construction activities were conducted adjacent to active nests. This impact would be potentially significant.

Dam construction, vegetation removal, and inundation resulting from a 6.5-foot dam raise would result in a loss of approximately 954 acres in the impoundment area and 390 acres in the relocation areas of potential nesting and foraging habitat for the Vaux’s swift. These activities would also result in the loss of approximately 28 acres in the impoundment area and 0.72 acre in the relocation areas of willow flycatcher, yellow warbler, and yellow-breasted chat habitat. The loss of habitat for these species would be a potentially significant impact.

Impacts on suitable willow flycatcher, Vaux’s swifts, yellow warblers, and yellow-breasted chats habitat by CWHR type in the impoundment area and relocation areas are summarized in Table 13-15. Mitigation for this impact is proposed in Section 13.3.5.

Table 13-15. Impacts on Suitable Habitat for the Vaux's Swift, Willow Flycatcher, Yellow Warbler, and Yellow-Breasted Chat in the Impoundment Area and Relocation Areas (6.5-Foot Dam Raise)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Impoundment Area							
Vaux's Swift							
Douglas-fir	0.00	0.00	0.00	0.01	0.00	0.00	0.01
Klamath mixed conifer	0.00	0.00	0.00	0.00	0.00	5.51	5.51
Montane hardwood	39.08	18.13	86.75	34.61	9.44	39.49	227.49
Montane hardwood–conifer	34.65	0.50	69.23	66.31	55.70	89.81	316.21
Montane riparian	1.54	2.48	15.92	4.60	0.58	2.59	27.71
Ponderosa pine	108.93	15.36	84.75	81.20	25.06	61.89	377.20
Total Vaux's Swift Habitat	184.21	36.46	256.65	186.73	90.77	199.30	954.12
Willow Flycatcher, Yellow Warbler, and Yellow-Breasted Chat							
Montane riparian	1.54	2.48	15.92	4.60	0.58	2.59	27.71
Total Habitat	1.54	2.48	15.92	4.60	0.58	2.59	27.71
Relocation Areas							
Vaux's Swift							
Montane hardwood	19.73	0.00	20.89	21.64	0.24	0.13	62.63
Montane hardwood–conifer	24.67	0.00	19.27	33.48	2.61	6.62	86.66
Montane riparian	0.08	0.00	0.33	0.25	0.04	0.02	0.72
Ponderosa pine	79.56	0.00	96.79	47.57	16.04	0.77	240.74
Total Vaux's Swift Habitat	124.06	0.00	137.28	102.95	18.93	7.54	390.75
Willow Flycatcher, Yellow Warbler, and Yellow-Breasted Chat							
Montane riparian	0.08	0.00	0.33	0.25	0.04	0.02	0.72
Total Habitat	0.08	0.00	0.33	0.25	0.04	0.02	0.72

Note:
[1] Acreage values are approximate.

Impact Wild-9 (CP1): Impacts on the Long-Eared Owl, Northern Goshawk, Cooper's Hawk, Great Blue Heron, and Osprey and Their Foraging and Nesting Habitat Construction activities and vegetation removal associated with the dam construction activities, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas during the nesting season could result in the incidental loss of fertile eggs or nestlings or otherwise lead to the abandonment of nests of the long-eared owl, a California species of special concern and an MSCS-covered species; northern goshawk, a California species of special concern, a USFS sensitive species, and a BLM sensitive species; and the Cooper's hawk, the great blue heron, and the osprey, which are MSCS-covered species. Higher lake levels caused by raising Shasta Dam would result in the loss of foraging and nesting habitat for the long-eared owl, northern goshawk, and Cooper's hawk. This impact would be potentially significant. Higher lake levels would also result in the loss of nesting habitat for osprey and great blue heron. This impact would be potentially significant. Foraging habitat would increase for osprey and great blue heron. No impact to foraging habitat for these species would occur.

Vegetation removal within the impoundment area during the nesting season could result in the incidental loss of fertile eggs or nestlings or otherwise lead to the abandonment of nests of these species. Noise generated by vegetation removal activities, including helicopter yarding and chainsaw use, could also lead to nest abandonment, resulting in the incidental loss of fertile eggs or nestlings. This impact would be potentially significant. The loss of nesting and foraging habitat would be a potentially significant impact.

A 6.5-foot dam raise could result in inundation of nest trees and would result in the loss of nesting and foraging habitat for this species. When inundation of the impoundment area occurs, nest trees within the impoundment area would die. Because peak inundation generally occurs in late April through early June, nest trees would be flooded toward the end of the nesting season. If these species were nesting in these trees, it is likely that young would fledge before the nest tree dies from the effects of inundation. Because of inundation timing, it is not likely that individuals would be affected. However, the loss of nesting and foraging habitat would be a potentially significant impact.

The increase in lake elevation could increase access to nests by recreational boaters. The increase in noise and human disturbance could lead to nest abandonment and the incidental loss of fertile eggs or young. This would be a potentially significant impact.

Construction activities, such as tree removal, site grading, excavation, and vegetation removal, at the dam and in relocation areas during the nesting season could result in the incidental loss of fertile eggs or nestlings or otherwise lead to nest abandonment. Additionally, noise generated by project construction activities and vegetation removal, including helicopter yarding and chainsaw use, could lead to nest abandonment, resulting in the incidental loss of fertile eggs or nestlings. Vegetation removal in relocation areas would also result in a loss of nesting and foraging habitat. This would be a potentially significant impact.

Impacts on these species could occur over multiple years during project implementation if construction activities were conducted adjacent to active nests. This impact would be potentially significant.

Dam construction, vegetation removal, and inundation resulting from a 6.5-foot dam raise would result in a loss of approximately 699 acres in the impoundment area and 327 acres in the relocation areas of long-eared owl and northern goshawk nesting and foraging habitat. There would be a loss of approximately

1,072 acres in the impoundment area and 402 acres in the relocation areas of Cooper's hawk and great blue heron nesting and foraging habitat.

Impacts on suitable habitat by CWHR type in the impoundment area and relocation areas are summarized in Table 13-16.

Table 13-16. Impacts on Suitable Habitat for the Long-Eared Owl, Northern Goshawk, Cooper's Hawk, and Great Blue Heron in the Impoundment Area and Relocation Areas (6.5-Foot Dam Raise)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Impoundment Area							
Long-Eared Owl and Northern Goshawk							
Douglas-fir	0.00	Douglas-fir	0.00	Douglas-fir	0.00	Douglas-fir	0.00
Klamath mixed conifer	0.00	Klamath mixed conifer	0.00	Klamath mixed conifer	0.00	Klamath mixed conifer	0.00
Montane hardwood–conifer	34.65	Montane hardwood–conifer	34.65	Montane hardwood–conifer	34.65	Montane hardwood–conifer	34.65
Ponderosa pine	108.93	Ponderosa pine	108.93	Ponderosa pine	108.93	Ponderosa pine	108.93
Total Habitat	143.59	Total Habitat	143.59	Total Habitat	143.59	Total Habitat	143.59
Cooper's Hawk and Great Blue Heron							
Blue oak–foothill pine	4.96	0.00	0.00	0.00	1.40	16.35	22.71
Closed-cone pine-cypress	17.75	0.00	6.30	10.78	23.95	36.71	95.49
Douglas-fir	0.00	0.00	0.00	0.01	0.00	0.00	0.01
Klamath mixed conifer	0.00	0.00	0.00	0.00	0.00	5.51	5.51
Montane hardwood	39.08	18.13	86.75	34.61	9.44	39.49	227.49
Montane hardwood–conifer	34.65	0.50	69.23	66.31	55.70	89.81	316.21
Montane riparian	1.54	2.48	15.92	4.60	0.58	2.59	27.71
Ponderosa pine	108.93	15.36	84.75	81.20	25.06	61.89	377.19
Total Habitat	206.91	36.46	262.95	197.51	116.13	252.36	1072.33

Table 13-16. Impacts on Suitable Habitat for the Long-Eared Owl, Northern Goshawk, Cooper's Hawk, and Great Blue Heron in the Impoundment Area and Relocation Areas (6.5-Foot Dam Raise) (contd.)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Relocation Areas							
Long-Eared Owl and Northern Goshawk							
Douglas-fir	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Montane hardwood–conifer	24.69	0.00	19.27	33.48	2.61	6.62	86.66
Ponderosa pine	79.56	0.00	96.78	47.58	16.04	0.77	240.74
Total Habitat	104.25	0.00	116.05	81.06	116.05	7.38	327.40
Cooper's Hawk and Great Blue Heron							
Blue oak–foothill pine	0.01	0.00	0.00	0.00	0.00	2.34	2.36
Closed-cone pine-cypress	0.05	0.00	5.65	2.23	0.23	0.94	9.10
Douglas-fir	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Montane hardwood	19.73	0.00	20.89	21.64	0.24	0.13	62.63
Montane hardwood–conifer	24.68	0.00	19.27	33.48	2.61	6.62	86.66
Montane riparian	0.08	0.00	0.33	0.25	0.04	0.02	0.72
Ponderosa pine	79.56	0.00	96.79	47.58	16.04	0.77	240.74
Total Habitat	124.12	0.00	142.93	105.19	19.16	10.82	402.22

Note:
[1] Acreage values are approximate.

Impacts on osprey are similar to those described for the bald eagle (Impact Wild-5 (CP1)) and the other raptors addressed above.

There are 54 osprey nest trees along the perimeter of Shasta Lake. Six nest trees would be affected by a 6.5-foot dam raise. Eleven osprey nests are located in relocation areas. Removal of nest trees would be a potentially significant impact. Because osprey generally use the same nest for multiple years, the loss of 17 nest trees (31 percent of the total in the Shasta Lake and vicinity) between the impoundment area and relocation areas would be a potentially significant impact.

Osprey nests also occur on towers and structures around the dam; otherwise, there is no suitable habitat for raptors near the dam. Blasting may occur in the vicinity of the dam. This would have a similar impact on nesting ospreys as noise generated by helicopter yarding or large construction equipment, which could result in nest abandonment and the loss of fertile eggs or young. This would be a potentially significant impact.

Impact Wild-10 (CP1): Take and Loss of Habitat for the Pacific Fisher
Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas would result in a loss of habitat for the Pacific fisher, a Federal candidate for listing, a California species of special concern, a USFS sensitive species, and a BLM sensitive species. Furthermore, take (including mortality of individuals because of destruction or disturbance of active roost sites or dens) could result from construction activities and vegetation clearing. This impact would be potentially significant.

Vegetation removal within the impoundment area while Pacific fisher kits (i.e., young) are in natal den trees could result in the incidental loss of kits. Noise generated by vegetation removal activities, including helicopter yarding and chainsaw use, may also lead to abandonment of young. However, females frequently move kits if the natal den is disturbed or threatened. Because females will move kits, it is not likely that individuals would be affected. However, the loss of denning, resting, and foraging habitat would be a potentially significant impact.

A 6.5-foot dam raise could result in inundation of natal den trees and would result in the loss of denning, resting, and foraging habitat for this species. When inundation of the impoundment area occurs, natal den trees within the impoundment area would die. Females frequently move kits if threatened or disturbed. Because females will move kits, it is not likely that individuals would be affected. However, the loss of denning, resting, and foraging habitat would be a potentially significant impact.

Construction activities, such as tree removal, site grading, excavation, and vegetation removal, at the dam and in relocation areas while kits are in natal den trees could result in the incidental loss of kits. Impacts on habitat would be the same as described for the impoundment area. This would be a potentially significant impact.

Impacts on the Pacific fisher could occur over multiple years during project implementation if construction activities were conducted adjacent to denning or resting habitat. This impact would be potentially significant.

Dam construction, vegetation removal, and inundation resulting from a 6.5-foot dam raise would result in a loss of approximately 749 acres of Pacific fisher habitat in the impoundment area. Approximately 330 acres of Pacific fisher habitat would be lost in the relocation areas. This impact would be potentially significant.

Impacts on suitable habitat by CWHR type in the impoundment area and relocation areas are summarized in Table 13-17.

Mitigation for this impact is proposed in Section 13.3.5.

Table 13-17. Impacts on Suitable Habitat for the Pacific Fisher in the Impoundment Area and Relocation Areas (6.5-Foot Dam Raise)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Impoundment Area							
Blue oak-foothill pine	4.95	0.00	0.00	0.00	1.40	16.35	22.71
Douglas-fir	0.00	0.00	0.00	0.01	0.00	0.00	0.01
Klamath mixed conifer	0.00	0.00	0.00	0.00	0.00	5.51	5.51
Montane hardwood–conifer	34.65	0.50	69.23	66.31	55.70	89.81	316.21
Montane riparian	1.54	2.48	15.92	4.60	0.58	2.59	27.71
Ponderosa pine	108.93	15.36	84.75	81.20	25.06	61.89	377.19
Total Habitat	150.08	18.34	169.90	152.12	82.74	176.16	749.34
Relocation Areas							
Blue oak-foothill pine	0.01	0.00	0.00	0.00	0.00	2.35	2.36
Douglas-fir	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Montane hardwood–conifer	24.69	0.00	19.27	33.48	2.61	6.62	86.66
Montane riparian	0.08	0.00	0.33	0.25	0.04	0.02	0.72
Ponderosa pine	96.78	0.00	96.79	47.58	16.04	0.77	240.74
Total Habitat	104.34	0.00	116.39	81.31	18.69	9.75	330.48

Note:
[1] Acreage values are approximate.

Impact Wild-11 (CP1): Impacts on Special-Status Bats (Pallid Bat, Spotted Bat, Western Red Bat, Western Mastiff Bat, Townsend's Big-Eared Bat, Long-Eared Myotis, Yuma Myotis, and Fringed Myotis), the American Marten, and Ringtail and Their Habitat Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas would result in a loss of habitat for the pallid bat, a California species of special concern, a USFS sensitive species, and a BLM sensitive species; the western red bat, a USFS sensitive species; the western mastiff bat, a California species of special concern, an MSCS-covered species, and a BLM sensitive species; the Townsend's big-eared bat, a California species of special concern, a USFS sensitive species, and a BLM sensitive species; the long-eared myotis, a BLM sensitive species; the Yuma myotis, a BLM sensitive species; the fringed myotis, a USFS sensitive species; the American marten, a USFS sensitive species; and the ringtail, a State fully protected and MSCS-covered species. Furthermore, take (including mortality of individuals because of destruction or disturbance of active roost sites or dens) could result from construction activities and vegetation clearing. This impact would be potentially significant.

Vegetation removal within the impoundment area while young bats are in maternity colonies or kits are in natal den trees could result in the incidental loss of young. Noise generated by vegetation removal activities, including helicopter yarding and chainsaw use, could also lead to young abandonment. Furthermore, depending on the season, the removal of large trees with cavities could result in the loss of pallid bat and Townsend's big-eared bat colonies. Potential direct impacts include the take of a maternity colony (females and young) and the take of individuals in a hibernaculum, which could eliminate an entire colony because of the loss of pregnant females. Mortality of young and the loss of reproductive and foraging habitat would be a potentially significant impact.

Inundation of a 6.5-foot dam raise would result in a loss of roosting and foraging habitat for special-status bats (pallid bat, spotted bat, western red bat, western mastiff bat, Townsend's big-eared bat, long-eared myotis, Yuma myotis, and fringed myotis) that roost in hollow trees, snags, bridges, and caves. Loss of young could occur during the first inundation (above 1,070 feet msl) of bat maternity colony habitat because active maternity colonies could be flooded before young are volant (capable of flight). American marten and ringtails, which also use snags, hollow logs, and debris piles for reproduction and cover, could also be impacted. This impact would be potentially significant.

Two known caves, one occupied by Townsend's big-eared bats, are located on the Big Backbone Arm and would be wholly or partially inundated if the dam were raised. Inundation of cave/cliff habitat could result in the loss of Townsend's big-eared bat, western mastiff bat, and long-eared myotis colonies. Potential direct impacts include the take of a maternity colony and the take of individuals in a hibernaculum, which could eliminate an entire colony because of the loss of pregnant females.

Spotted bats and long-eared myotis could also roost in crevices and caves in the Shasta Lake and vicinity portion of the primary study area. However, inundation of cave/cliff habitat is less likely to result in a significant impact on these species because they do not roost colonially; thus, inundation of a cave would not result in the loss of an entire maternity colony.

Special-status bats may roost on bridges and could also be affected by bridge modification or removal. Direct impacts, including mortality and the loss of roosting habitat, would be significant.

Construction activities, such as tree removal, site grading, excavation, and vegetation removal, at the dam and in relocation areas while young bats are in maternity colonies or kits are in natal den trees could result in the incidental loss of young. Impacts on habitat would be the same as described for the impoundment area. This would be a potentially significant impact.

Impacts on these species could occur over multiple years during project implementation if construction activities are conducted in or adjacent to reproductive habitat. This impact would be potentially significant.

Foraging habitat for the pallid bat, spotted bat, western mastiff bat, and Townsend's big-eared bat includes Douglas-fir, fresh emergent wetland, lacustrine habitat, montane hardwood, montane hardwood–conifer, montane riparian, and ponderosa pine. These habitats are regionally abundant and therefore impacts on foraging habitat by inundation or vegetation removal in the relocation areas would be less than significant.

Dam construction, vegetation removal, and inundation resulting from a 6.5-foot dam raise would result in the loss of approximately 31 acres of reproductive and roosting habitat for the pallid bat, spotted bat, western mastiff bat, Townsend's big-eared bat, Yuma myotis, and fringed myotis in the impoundment area. Approximately 35 acres of reproductive and roosting habitat for these species would be lost in the relocation areas. Additionally, one limestone cave located on the Big Backbone Arm that is a known Townsend's big-eared bat roost would be affected by flooding. A 6.5-foot dam raise would result in the loss of approximately 1,201 acres of reproductive and roosting habitat for the western red bat and long-eared myotis. Approximately 457 acres of reproductive and roosting habitat for these species would be lost in the relocation areas. These impacts would be potentially significant.

Dam construction, vegetation removal, and inundation resulting from a 6.5-foot dam raise would result in the loss of approximately 1,201 acres of ringtail habitat. Approximately 457 acres of ringtail habitat would be lost in the relocation areas. A 6.5-foot dam raise would result in the loss of approximately 724 acres of American marten habitat in the impoundment area and 328 acres in the relocation areas. These impacts would be potentially significant.

Impacts on suitable habitat by CWHR type in the impoundment area and relocation areas are summarized in Table 13-18.

Mitigation for this impact is proposed in Section 13.3.5.

Table 13-18. Impacts on Suitable Habitat for Special-Status Bats, American Marten, and Ringtail in the Impoundment Area and Relocation Areas (6.5-Foot Dam Raise)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Impoundment Area							
Townsend's Big-Eared Bat, Spotted Bat, Pallid Bat, Western Mastiff Bat, Yuma Myotis, and Fringed Myotis							
Barren	1.02	0.64[2]	4.04	0.85	0.00	0.59	6.50
Blue oak woodland	0.00	0.00	0.00	0.00	0.00	2.21	2.21
Blue oak–foothill pine	4.96	0.00	0.00	0.00	1.40	16.35	22.71
Total Habitat	5.98	0.00	4.04	0.85	1.40	19.16	31.43
Western Red Bat, Long-Eared Myotis, and Ringtail							
Barren	1.02	0.00	4.04	0.85	0.00	0.59	6.50
Blue oak woodland	0.00	0.00	0.00	0.00	0.00	2.21	2.21
Blue oak–foothill pine	4.96	0.00	0.00	0.00	1.40	16.35	22.71
Closed-cone pine-cypress	17.75	0.00	6.30	10.78	23.95	36.71	95.49
Douglas-fir	0.00	0.00	0.00	0.01	0.00	0.00	0.01
Klamath mixed conifer	0.00	0.00	0.00	0.00	0.00	5.51	5.51
Mixed chaparral	14.83	6.83	80.01	7.32	5.43	5.66	120.07
Montane hardwood	39.08	18.13	86.75	34.61	9.44	39.49	227.49
Montane hardwood–conifer	34.65	0.50	69.23	66.31	55.70	89.81	316.21
Montane riparian	1.54	2.48	15.92	4.60	0.58	2.59	27.71
Ponderosa pine	108.93	15.36	84.75	81.20	25.06	61.89	377.19
Total Habitat	222.76	43.30	347.00	205.68	121.56	260.81	1201.01
American Marten							
Douglas-fir	0.00	0.00	0.00	0.01	0.00	0.00	0.01
Klamath mixed conifer	0.00	0.00	0.00	0.00	0.00	3.36	3.36
Montane hardwood–conifer	34.65	0.50	69.23	66.31	55.70	89.81	316.21
Montane riparian	1.54	2.48	15.92	4.60	0.58	2.59	27.71
Ponderosa pine	108.93	15.36	84.75	81.20	25.06	61.89	377.19
Total Habitat	145.13	18.34	169.90	152.12	81.34	157.66	724.48

Table 13-18. Impacts on Suitable Habitat for Special-Status Bats, American Marten, and Ringtail in the Impoundment Area and Relocation Areas (6.5-Foot Dam Raise) (contd.)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Relocation Areas							
Townsend's Big-Eared Bat, Spotted Bat, Pallid Bat, Western Mastiff Bat, Yuma Myotis, and Fringed Myotis							
Barren	12.46	0.00	11.97	5.37	0.00	2.96	32.76
Blue oak woodland	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Blue oak–foothill pine	0.01	0.00	0.00	0.00	0.00	2.35	2.36
Total Habitat	12.47	0.00	0.00	5.37	0.00	5.34	35.12
Western Red Bat, Long-Eared Myotis, and Ringtail							
Barren	12.46	0.00	11.96	5.37	0.00	2.96	32.76
Blue oak woodland	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Blue oak–foothill pine	0.01	0.00	0.00	0.00	0.00	2.35	2.36
Closed-cone pine-cypress	0.05	0.00	5.65	2.23	0.23	0.94	9.11
Douglas-fir	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mixed chaparral	3.36	0.00	3.95	4.11	1.70	9.63	22.77
Montane hardwood	19.73	0.00	20.89	21.64	0.24	0.13	62.63
Montane hardwood–conifer	24.69	0.00	19.27	33.48	2.61	6.62	86.66
Montane riparian	0.08	0.00	0.33	0.25	0.04	0.02	0.72
Ponderosa pine	79.56	0.00	96.79	47.56	16.04	0.77	240.74
Total Habitat	139.94	0.00	158.84	114.68	20.86	23.42	457.74
American Marten							
Douglas-fir	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Montane hardwood–conifer	24.69	0.00	19.27	33.49	2.61	6.62	86.66
Montane riparian	0.08	0.00	0.33	0.25	0.04	0.25	0.72
Ponderosa pine	79.56	0.00	96.79	47.58	16.04	47.58	240.74
Total Habitat	104.33	0.00	116.39	81.31	18.69	328.12	328.12

Note:
[1] Acreage values are approximate.

Impact Wild-12 (CP1): Impacts on Special-Status Terrestrial Mollusks (Church's Sideband, Shasta Sideband, Wintu Sideband, Oregon Shoulderband, Shasta Chaparral, and Shasta Hesperian) and Their Habitat All of these species are designated USFS sensitive and/or S&M species, and the Shasta sideband is also an MSCS-covered species. The Shasta Sideband, Wintu Sideband, Shasta Chaparral, and Shasta Hesperian have also been petitioned for Federal listing. Ground-disturbing activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas could result in direct take and/or loss of suitable habitat for special-status terrestrial mollusks.

In addition, the raising of Shasta Dam would result in the inundation of suitable habitat and direct take of these species. This impact would be significant.

These species are found in nearly all CWHR habitats along the lake. The Shasta sideband and Wintu sideband are associated with limestone formations in the McCloud River and in the Pit and Squaw Creek arms, respectively. For the purposes of this impact analysis for Shasta sideband and Wintu sideband, all CWHR habitats in the impoundment and relocation areas are stratified as limestone or nonlimestone habitat. Shasta chaparral occurs in many CWHR habitats and Shasta hesperian is found in riparian habitats.

Vegetation removal in the impoundment areas and construction activities, such as tree removal, site grading, excavation, and vegetation removal at the dam and in relocation areas in suitable habitat, could result in direct take. In addition, these activities and the inundation caused by a 6.5-foot dam raise would result in the mortality of individuals and the permanent loss of suitable habitat.

Dam construction, vegetation removal, and construction in the relocation areas, and inundation resulting from a 6.5-foot dam raise would result in the loss of approximately 1,195 and 425 acres of Church's sideband, Oregon shoulderband, and Shasta chaparral habitat in the impoundment area and relocation areas, respectively. Shasta hesperian habitat loss in the impoundment area and relocation areas would be approximately 28 and 0.72 acre, respectively. The 6.5-foot dam raise would also result in the loss of approximately 5 acres of Shasta sideband habitat in the impoundment area and 0.97 acre in the relocation areas. Wintu sideband habitat loss includes approximately 1.50 acres in the impoundment area. These impacts would be potentially significant.

Impacts on suitable habitat by CWHR type in the impoundment area and relocation areas are summarized in Table 13-19.

Mitigation for this impact is proposed in Section 13.3.5.

Table 13-19. Impacts on Suitable Habitat for Special-Status Terrestrial Mollusks in the Impoundment Area and Relocation Areas (6.5-Foot Dam Raise)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Impoundment Area: Shasta Sideband							
Limestone	0.00	0.00	0.00	5.43	0.00	0.00	5.43
Impoundment Area: Wintu Sideband							
Limestone	0.00	0.00	0.00	0.00	0.00	1.50	1.50
Impoundment Area: Church's sideband, Oregon Shoulderband, Shasta Chaparral							
Barren	0.57	0.00	0.25	0.00	0.00	0.00	0.81
Blue oak woodland	0.00	0.00	0.00	0.00	0.00	2.21	2.21
Blue oak–foothill pine	4.96	0.00	0.00	0.00	1.40	16.36	22.71
Closed-cone pine–cypress	17.75	0.00	6.30	10.74	23.95	36.71	95.49
Douglas-fir	0.00	0.00	0.00	0.01	0.00	0.00	0.01
Klamath mixed conifer	0.00	0.00	0.00	0.00	0.00	5.51	5.51
Mixed chaparral	14.83	6.83	80.01	7.32	5.43	5.65	120.07
Montane hardwood	39.08	18.13	86.75	34.61	9.44	39.49	227.49
Montane hardwood–conifer	34.65	0.50	69.23	66.31	55.70	89.81	316.21
Montane riparian	1.54	2.48	15.92	4.60	0.58	2.59	27.71
Ponderosa pine	108.93	15.36	84.75	81.20	25.06	61.89	377.19
Total Habitat	222.31	43.30	343.21	204.83	121.56	260.23	1195.43
Impoundment Area: Shasta Hesperian							
Montane riparian	1.54	2.48	15.92	4.60	0.58	2.59	27.71
Total Habitat	1.54	2.48	15.92	4.60	0.58	2.59	27.71
Relocation Areas: Shasta Sideband							
Limestone	0.00	0.00	0.00	0.97	0.00	0.00	0.97
Relocation Areas: Wintu Sideband							
Limestone	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Relocation Areas: Church's sideband, Oregon Shoulderband, Shasta Chaparral							
Barren	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Blue oak woodland	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Blue oak–foothill pine	0.01	0.00	0.00	0.00	0.00	2.35	2.36
Closed-cone pine–cypress	0.05	0.00	5.65	5.65	0.23	0.94	9.11
Douglas-fir	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mixed chaparral	3.36	0.00	3.95	3.95	1.70	9.63	22.77
Montane hardwood	19.73	0.00	20.89	20.89	0.24	0.13	62.63
Montane hardwood–conifer	24.69	0.00	19.27	19.27	2.61	6.62	86.66

Table 13-19. Impacts on Suitable Habitat for Special-Status Terrestrial Mollusks in the Impoundment Area and Relocation Areas (6.5-Foot Dam Raise) (contd.)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Relocation Areas: Church's sideband, Oregon Shoulderband, Shasta Chaparral (contd.)							
Montane riparian	0.08	0.00	0.33	0.33	0.04	0.02	0.72
Ponderosa pine	79.56	0.00	96.78	96.79	16.04	0.77	240.74
Total Habitat	127.48	0.00	146.88	146.88	20.86	20.46	424.98
Relocation Areas: Shasta Hesperian							
Montane riparian	0.08	0.00	0.33	0.25	0.04	0.02	0.72
Total Habitat	0.08	0.00	0.33	0.25	0.04	0.02	0.72

Note:
[1] Acreage values are approximate.

Impact Wild-13 (CP1): Permanent Loss of General Wildlife Habitat and Western Bumble Bee Habitat The western bumblebee is designated USFS sensitive. Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas would result in a permanent loss of habitat. In addition, inundation caused by the raising of Shasta Dam would result in the permanent loss of habitat. This would be a potentially significant impact.

These general habitats also represent potential western bumble bee habitat. Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas would result in a permanent loss of habitat containing flowering shrubs and forbs, which serve as potential Western bumble bee nectar sources and potential underground burrow locations. In addition, inundation caused by the raising of Shasta Dam would result in the permanent loss of habitat. This would be a potentially significant impact.

Dam construction, vegetation removal and construction in the relocation areas, and inundation resulting from a 6.5-foot dam raise would result in a loss of 1,227 acres of general wildlife and western bumble bee habitat in the impoundment area and 698 acres of general wildlife and western bumble bee habitat in the relocation areas. Impacts on general wildlife and western bumble bee habitat by CWHR type in the impoundment area and relocation areas are summarized in Tables 13-20 and 13-21.

Mitigation for this impact is proposed in Section 13.3.5.

Table 13-20. Impacts on CWHR Habitats and Western Bumble Bee Habitat in the Impoundment Area (6.5-Foot Dam Raise)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Annual grassland	0.07	0.00	0.96	0.37	0.00	0.37	1.78
Barren	1.02	0.00	4.04	0.85	0.00	0.59	6.50
Blue oak–foothill pine	4.96	0.00	0.00	0.00	1.40	16.35	22.71
Blue oak woodland	0.00	0.00	0.00	0.00	0.00	2.21	2.21
Closed-cone pine–cypress	17.75	0.00	6.30	10.78	23.95	36.71	95.49
Douglas-fir	0.00	0.00	0.00	0.01	0.00	0.00	0.01
Klamath mixed conifer	0.00	0.00	0.00	0.00	0.00	5.51	5.51
Mixed chaparral	14.83	6.83	80.01	7.32	5.43	5.65	120.07
Montane hardwood	39.08	18.13	86.75	34.61	9.44	39.49	227.49
Montane hardwood–conifer	34.65	0.50	69.23	66.31	55.70	89.81	316.21
Montane riparian	1.54	2.48	15.92	4.60	0.58	2.59	27.71
Ponderosa pine	108.93	15.36	84.75	81.20	25.06	61.89	377.19
Riverine	0.00	0.35	2.30	3.81	0.59	0.00	7.05
Urban	10.95	0.00	1.37	4.74	0.00	0.26	17.33
Total	233.79	43.65	351.64	214.60	122.14	261.46	1227.27

Note:
[1] Acreage values are approximate.
Key:
CWHR = California Wildlife Habitat Relationships

Table 13-21. Impacts on CWHR Habitats and Western Bumble Bee Habitat in the Relocation Areas

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Annual grassland	0.40	0.00	4.95	0.53	0.70	0.01	6.59
Barren	12.46	0.00	11.97	5.38	0.00	2.96	32.76
Blue oak–foothill pine	0.01	0.00	0.00	0.00	0.00	2.35	2.36
Blue oak woodland	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Closed-cone pine–cypress	0.05	0.00	5.65	2.23	0.23	0.94	9.11
Douglas-fir	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mixed chaparral	3.36	0.00	3.95	4.11	1.70	9.63	22.77
Montane hardwood	19.73	0.00	20.89	21.64	0.24	0.13	62.63
Montane hardwood–conifer	24.69	0.00	19.27	33.48	2.61	6.62	86.66
Montane riparian	0.08	0.00	0.33	0.25	0.04	0.02	0.72
Ponderosa pine	79.56	0.00	96.78	47.58	16.04	0.77	240.74

Table 13-21. Impacts on CWHR Habitats and Western Bumble Bee Habitat in the Relocation Areas (contd.)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Riverine	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Urban	15.64	0.00	217.29	0.27	0.00	0.57	233.76
Total	155.98	0.00	381.09	115.47	21.56	23.99	698.10

Note:
[1] Acreage values are approximate.
Key:
CWHR = California Wildlife Habitat Relationships

Impact Wild-14 (CP1): Impacts on Other Birds of Prey (e.g., red-tailed hawk and red-shouldered hawk) and Migratory Bird Species (e.g., American robin, Anna's hummingbird) and their Foraging and Nesting Habitat Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas during the nesting season could result in the incidental loss of fertile eggs or nestlings or otherwise lead to the abandonment of nests of other birds of prey and migratory bird species. In addition, inundation caused by the raising of Shasta Dam could result in the loss of active nests and habitat for these species. This impact would be potentially significant.

Approximately 36 percent of the impoundment area would be subject to either complete (15 percent) or overstory (21 percent) vegetation removal. If vegetation removal were to occur before or after the breeding season, there would be no impact on migratory birds or raptors. When inundation of the impoundment area occurs, nest trees within the impoundment area would die. Because peak inundation generally occurs between late April and early June, nest trees would be flooded toward the end of the nesting season. If raptors were nesting in these trees, it is likely the young would fledge before the nest tree died from the effects of inundation. However, approximately 84 percent of understory vegetation inundated could have ground or shrub nesting birds that would be impacted by inundation. Impacts on ground or understory nesters would be potentially significant.

Maximum inundation would occur in late April through early June during the breeding season and many nests could be established before and while lake levels are rising. In the portions of the impoundment area where vegetation removal is not implemented, active bird nests would flood, resulting in mortality of young still dependent on the nest. This would be a potentially significant impact.

Additionally, removal of structures providing for raptor nests (e.g., power poles) in the relocation areas could result in mortality of young. This would be a potentially significant impact.

Vegetation in relocation areas would be completely removed. If vegetation removal occurred during the breeding season, there would a potentially significant impact on migratory birds or raptors.

Impacts on these species could occur over multiple years during project implementation if construction activities were conducted in or adjacent to reproductive habitat. This impact would be potentially significant. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-15 (CP1): Loss of Critical Deer Winter and Fawning Range Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas would result in a loss of critical deer winter and fawning range. In addition, inundation caused by the raising of Shasta Dam would result in the loss of critical deer range. This impact would be potentially significant.

Impacts caused by construction and vegetation clearing for the dam and relocation areas under a 6.5-foot raise of Shasta Dam would result in the loss of approximately 3,962 acres of critical deer winter and/or fawning range. This impact would be potentially significant. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-16 (CP1): Take and Loss of the California Red-Legged Frog Reclamation completed California red-legged frog habitat assessments in coordination with the USFWS in the applicable impoundment and relocation areas, and the potential downstream Sacramento River restoration sites. The assessment results will enable Reclamation and the USFWS to determine if habitat for the species occurs, if impacts are anticipated, and if additional surveys are needed. Impacts on the California red-legged frog will be assessed if surveys are conducted and the California red-legged frog is found. Impacts for each alternative will not be assessed until USFWS has determined whether suitable habitat is present and whether surveys would be required. Mitigation for this impact is discussed in Section 13.3.5.

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact Wild-17 (CP1): Impacts on Riparian-Associated Special-Status Wildlife Resulting from Modifications to the Existing Flow Regime in the Primary Study Area Implementing CP1 would increase available water storage in Shasta Reservoir and result in a modified flow regime, which would modify the flow and stages of the upper Sacramento River. Monthly flow results were used to simulate mean daily flows. On average, in each month, changes in mean monthly flow would be reductions or increases of several percent, and often less than 2 percent. Changes of 2 percent or less are considered essentially equivalent to baseline operations and therefore do not represent a substantial change. Generally, these effects diminish with distance downstream because of the influence of inflows from tributaries and of diversions and flood bypasses.

Implementing CP1 would reduce the frequency, duration, and magnitude of intermediate to large flows downstream from Shasta Dam during winter (December through February) in some water years, especially wet and above-normal years, because of the increase in storage space that could be filled in some years, usually after dry or critical water years. Conversely, CP1 would increase flow volumes in fall of most years (September through November) because more water would be available for delivery in the driest months. During spring and summer (generally March through August), changes in mean monthly flows would be small reductions or increases (generally less than 2 percent) and typically would be transitional between small reductions in winter flows and small increases in summer flows.

These changes in surface and subsurface hydrology could affect habitats adjacent to the river channel and reduce the formation of off-channel habitats in the long term, which would adversely affect the habitat of western pond turtle.

The portion of riparian vegetation in early successional stages would be reduced, although the total amount of riparian vegetation would not decline substantially. These early successional stages provide habitat for some special-status wildlife species. These changes could result in substantial effects on the distribution or abundance of riparian-nesting special-status bird species, particularly western yellow-billed cuckoos. Because CP1 would substantially alter habitat for a variety of riparian-dependent special-status species, this impact would be potentially significant.

The operation of Shasta Dam has substantially modified the natural flow regime in the primary study area. As discussed previously, dam construction and operation has limited the frequency and magnitude of intermediate to large flows downstream from the dam in winter and spring, and has increased flow volumes during the active growing season (primarily March through October). Implementation of CP1 would be expected to amplify these effects (Table 13-22) because CP1 would increase available storage. These changes are most noticeable in the modeling data for wet and above-normal water years. Reducing the magnitude, frequency, and duration of intermediate to large flows could alter the dynamics and structure of wetland and riparian habitats that support special-status wildlife species along the Sacramento River, downstream from Shasta Dam, throughout the primary study area. (See Chapter 12, “Botanical Resources and Wetlands,” for more information.)

The effects of modified flow regimes would be somewhat attenuated downstream because of the cumulative tributary flow adding to the Sacramento River. However, many of these tributaries are also part of the CVP and SWP and would likely be operated differently should CP1 be implemented. CP1 would increase the volume of flows in summer and fall of most years, most dramatically in September and October. This change is also a result of increased storage, which allows more water to be available for delivery in the driest months of the year. Although the relative contribution of CP1 to overall changes downstream from Keswick Dam would attenuate, it appears based on the modeling that in September of dry and critical water years, the effect of CP1 would be a substantial increase in flows all the way down to Freeport (Table 13-22).

Special-status wildlife that could be affected by these changes include special-status invertebrates, reptiles, amphibians, birds, and mammals, as discussed below.

- **Invertebrates –** Blue elderberry shrubs, the host plants for the valley elderberry longhorn beetle, are found throughout much of the Sacramento River's riparian corridor. Shrubs within the corridor are unlikely to be affected by modification of the existing flow regimes. Elderberry shrubs are not commonly found growing immediately next to the river's edge, but are often found on floodplain terraces or higher up the bank. Most of the effect of CP1 on flow regime, including inundation during the growing season, would be concentrated in a narrow strip along the river channel that is already subjected to seasonal inundation. Elderberry shrubs growing in these areas already experience periodic seasonal inundation. CP1 would alter flows substantially (beyond the ±2 percent threshold), but the change in river stage is predicted by CalSim-II to generally be less than about 4 inches. Because of this relatively small vertical change in water surface elevation, implementing CP1 is not likely to prevent establishment or substantially reduce the vigor of existing elderberry shrubs in the primary study area. Therefore, the impact of CP1 on invertebrate species would be less than significant.

Table 13-22. Percent Change in Average Monthly Flows at Keswick Dam and Downstream Under CP1

Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Keswick Dam												
Wet	1.6%	0.8%	-6.0%	-2.9%	-0.5%	0.4%	0.3%	0.1%	0.2%	0.3%	0.3%	0.4%
Above Normal	5.1%	-1.5%	-1.4%	-2.2%	-5.2%	-2.2%	0.0%	-3.0%	-1.4%	0.1%	0.9%	5.9%
Below Normal	0.9%	-0.7%	0.1%	-0.9%	-0.7%	-1.1%	0.2%	-2.6%	1.1%	0.2%	0.0%	1.3%
Dry	2.4%	4.1%	-2.0%	-2.0%	-1.0%	0.0%	0.7%	1.4%	2.3%	1.5%	2.3%	3.9%
Critical	2.3%	4.8%	1.0%	-0.6%	1.7%	0.8%	1.0%	1.8%	0.6%	0.7%	-0.2%	5.6%
Bend Bridge												
Wet	1.4%	1.4%	-3.1%	-1.2%	-0.3%	0.3%	0.2%	0.1%	0.2%	0.3%	0.3%	0.4%
Above Normal	4.0%	-1.1%	-0.6%	-1.2%	-2.8%	-1.3%	0.0%	-2.1%	-1.0%	0.0%	0.8%	5.5%
Below Normal	0.8%	-0.1%	0.0%	-0.5%	-0.4%	-0.8%	0.1%	-1.6%	1.0%	0.2%	-0.1%	1.2%
Dry	2.1%	3.1%	-1.0%	-1.0%	-0.5%	0.0%	0.5%	1.1%	2.1%	1.5%	2.3%	3.6%
Critical	1.6%	3.9%	0.8%	-0.4%	1.5%	0.6%	0.8%	1.6%	0.5%	0.6%	-0.2%	5.2%
Butte City												
Wet	1.6%	2.0%	-2.3%	-0.7%	-0.2%	0.3%	0.1%	-0.1%	0.0%	0.2%	0.2%	0.4%
Above Normal	4.3%	-0.8%	-0.4%	-0.9%	-1.9%	-0.8%	0.2%	-2.4%	-1.2%	-0.3%	0.8%	5.8%
Below Normal	1.2%	0.2%	0.3%	-0.6%	-0.3%	-0.7%	-0.3%	-1.5%	1.4%	0.3%	0.0%	1.0%
Dry	2.4%	3.2%	-0.7%	-0.5%	-0.2%	0.0%	0.8%	1.0%	3.2%	2.3%	3.2%	3.8%
Critical	1.4%	4.3%	0.8%	-0.5%	1.4%	0.5%	1.1%	2.2%	0.6%	0.9%	-0.2%	4.8%
Wilkins Slough												
Wet	1.6%	2.2%	-1.6%	-0.2%	0.0%	0.3%	0.1%	-0.1%	0.0%	0.2%	0.2%	0.4%
Above Normal	4.3%	-0.8%	-0.4%	-0.6%	-1.1%	-0.4%	0.2%	-2.4%	-1.2%	-0.3%	0.8%	5.8%
Below Normal	1.2%	0.2%	0.3%	-0.6%	0.0%	-0.7%	-0.3%	-1.5%	1.4%	0.3%	0.0%	1.0%
Dry	2.4%	3.2%	-0.7%	-0.4%	-0.2%	0.0%	0.8%	1.0%	3.2%	2.3%	3.2%	3.8%
Critical	1.4%	4.3%	0.8%	-0.5%	1.4%	0.5%	1.1%	2.2%	0.6%	0.9%	-0.2%	4.8%
Verona												
Wet	1.5%	1.7%	-1.3%	-0.2%	0.0%	0.2%	0.1%	-0.2%	0.0%	0.1%	-0.1%	0.2%
Above Normal	3.2%	-0.1%	-0.3%	-0.4%	-1.3%	-0.2%	0.1%	-1.0%	-0.8%	-0.2%	0.4%	2.3%
Below Normal	0.6%	0.1%	-0.1%	0.0%	0.1%	-0.5%	-0.2%	-0.4%	1.4%	0.1%	-0.1%	-0.3%
Dry	1.3%	2.5%	-0.8%	-0.2%	-0.2%	0.0%	0.5%	0.7%	-1.0%	1.1%	1.8%	5.7%
Critical	0.5%	3.6%	0.8%	-0.2%	1.1%	0.4%	0.7%	2.0%	0.5%	0.8%	-1.5%	3.1%

Table 13-22. Percent Change in Average Monthly Flows at Keswick Dam and Downstream Under CP1 (contd.)

Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Freeport												
Wet	0.7%	0.5%	-0.3%	-0.2%	0.1%	0.1%	0.0%	-0.2%	0.0%	0.0%	0.0%	0.0%
Above Normal	1.2%	-0.5%	0.0%	0.0%	-0.5%	-0.1%	0.1%	-0.8%	-0.6%	-0.1%	0.0%	0.5%
Below Normal	-0.1%	-0.6%	0.5%	0.5%	0.3%	-0.3%	0.1%	-0.5%	0.3%	-0.1%	-0.4%	0.0%
Dry	1.2%	1.4%	-0.5%	-0.1%	-0.1%	-0.1%	0.2%	0.5%	-0.2%	0.7%	1.7%	4.3%
Critical	0.1%	1.8%	0.8%	-0.2%	0.9%	-0.1%	0.4%	0.9%	0.0%	1.4%	0.5%	2.4%

- **Reptiles and Amphibians –** The presence of western pond turtle within the Sacramento River has been documented, and suitable habitat for the species is provided in the primary study area, including tributaries. Although they will use low-velocity areas of the main channels, western pond turtles also rely on habitat types (e.g., oxbow lakes) that have relatively slow rates of formation. Creation of new off-channel water bodies requires periodic intermediate to large fall and winter flow events that drive the processes of meander migration and channel cutoff. Similarly, off-channel water bodies gradually become terrestrial habitats as they fill with sediment and organic detritus and are colonized by riparian vegetation. Consequently, activities that prevent the long-term formation of off-channel water bodies (e.g., constructing levees and installing bank armor) reduce the extent of this important type of habitat for pond turtles. The increase in mean stage elevation resulting from implementation of CP1 could provide additional aquatic habitat for the species during some months of some years. A key potentially limiting factor for the western pond turtle is the relationship between water level and flow in off-channel water bodies during the summer incubation season (Stillwater Sciences 2007). The Sacramento River stage and flows would not be substantially changed during summer; however, less aquatic habitat for western pond turtle could be available during winter, spring, and drought periods. Modifying the flow regime by capturing channel-forming flows could also reduce the formation of off-channel water bodies in the long term. These changes in habitat availability could reduce the size of the western pond turtle population along the Sacramento River in the long term by reducing turtle survival and reproductive success. Therefore, the impact of CP1 on the western pond turtle and its habitat would be potentially significant.

- **Birds –** The riparian and wetland habitats along the Sacramento River floodway provide potential nesting and foraging habitat for western yellow-billed cuckoo, California yellow warbler, and yellow-breasted chat, all of which are special-status birds that nest in riparian vegetation. In addition, northern harrier and short-eared owl may nest in marshes in or adjacent to the stream channel. Other raptors (e.g., Cooper's hawk, Swainson's hawk, white-tailed kite, bald eagle, and osprey) may nest in trees in the riparian or oak woodlands in the study area. As described above, altering the flow regime could alter some existing riparian habitat. Over time, there would be less early successional (willow, cottonwood, and herbaceous dominated) and more mid-successional (mixed woodland) vegetation, and a smaller amount of acreage recently disturbed by erosion or scouring after intermediate to large flows (see Chapter 12, "Botanical Resources and Wetlands.") These long-term changes to the structure of riparian vegetation are expected to change habitat values, causing the loss of, and in some cases expanding, nesting territories or affecting the reproductive success of some riparian foraging and nesting birds. The birds most adversely affected by this alteration would be those that make the most extensive use of willow thickets and cottonwood- and willow-dominated riparian forests, such as yellow-billed cuckoo and yellow-breasted chat. This loss of nesting habitat would eventually lead to a reduction in local populations of sensitive bird species as habitat became unsuitable for nesting. Although some species, such as raptors that nest in later successional riparian habitats, could benefit from the long-term changes, the impact of CP1 on special-status bird species that nest in early successional riparian vegetation would be potentially significant.

- **Mammals –** Special-status mammals potentially occurring in the project area include pallid bat, western red bat, and ringtail. Riparian habitat can provide important foraging and roosting habitat for bats, but these species are not typically dependent on riparian habitats. The amount of potential foraging habitat would not decrease under CP1, and available roosting areas in riparian habitats–even if modified by the new flow regime downstream from Shasta Dam–would not be subject to a substantial reduction. Therefore, the impact of CP1 on special-status bats would be less than significant. Potential changes in riparian vegetation along the river channel in the primary study area would not substantially reduce habitat for ringtail because this species is known to use a variety of habitats and forage on a wide array of items that would not be substantially altered (Belluomini 1980). Therefore, the impact of CP1 on special-status mammals would be less than significant.

Implementing CP1 would result in substantial long-term effects on the habitat of western pond turtle and some riparian-nesting special-status bird species. Therefore, this impact would be potentially significant. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-18 (CP1): Impacts on Bank Swallow in the Primary Study Area Resulting from Modifications of Geomorphic Processes Bank swallows generally benefit from bank erosion caused by high winter stream flow (which renews nesting habitat while they are in overwintering habitats to the south); high spring and summer flows, however, have the potential to adversely affect bank swallow colonies by destroying active nests (Stillwater Sciences 2007). Implementing CP1 would increase available water storage in Shasta Reservoir and result in a modified flow regime, which would modify the flow and stages of the upper Sacramento River. Monthly flow results were used to simulate mean daily flows; on average, in each month, changes in mean monthly flow would be reductions or increases of several percent, and often less than 2 percent. Changes of 2 percent or less are considered essentially equivalent to baseline operations and therefore do not represent a substantial change.

Generally, these effects diminish with distance downstream because of the influence of inflows from tributaries and of diversions and flood bypasses.

Implementing CP1 would reduce the frequency, duration, and magnitude of intermediate to large flows downstream from Shasta Dam during winter (December through February) in some water years, especially wet and above-normal years, because of the increase in storage space that could be filled in some years, usually after dry or critical water years. Conversely, CP1 would increase flow volumes in fall of most years (September through November) because more water would be available for delivery in the driest months. During spring and summer (generally March through August), changes in mean monthly flows would be small reductions or increases (generally less than 2 percent) and typically would be transitional between small reductions in winter flows and small increases in summer flows.

The rates of geomorphic processes, such as bank erosion and the average rate of meander migration, are strongly related to flow regime and the cumulative portion of flow exceeding a threshold volume. On portions of the Sacramento River, this threshold may be around 30,000 cubic feet per second (cfs) (Larsen et al. 2006; Stillwater Sciences 2007), which is well below the bankfull discharge but well above flows during spring and summer. However, other important thresholds for bank erosion and channel avulsion along the Sacramento River have been estimated within the range of 10,000–80,000 cfs (Stillwater Sciences 2007). For additional discussion of the relationship of geomorphic processes to flow along the Sacramento River, see the *Fisheries and Aquatic Ecosystem Technical Report*.

CalSim-II results temporally downscaled to mean daily values also indicate the relative magnitude of changes to the flow regime. The simulated change in mean daily discharges greater than 30,000 cfs below the Red Bluff Pumping Plant and Hamilton City is summarized in Figure 12-4 in Chapter 12, “Botanical Resources and Wetlands.” Flows of this magnitude strongly affect bank erosion and meander migration. Overall, these modeling results suggest only a very small change in flows greater than 30,000 cfs along the uppermost portion of the lower Sacramento River. This change is not likely sufficient to cause significant effects on bank swallow.

Any effects would likely occur along the upper Sacramento River throughout the primary study area. In the primary study area, changes in the number of mean daily flows within the magnitude of intermediate and large flows (i.e., greater than 30,000 cfs), which affect bank erosion and meander migration, would be small. Downstream from Keswick Dam and the Red Bluff Pumping Plant, the number of days with mean flows greater than 30,000 cfs would be reduced by approximately 9 and 2 percent, respectively.

Therefore, although there would be a slight alteration of the river’s geomorphic processes in some years and the rate of bank erosion would be reduced, the length of eroding banks would not be substantially altered, and thus, nesting habitat for bank swallows would not decline substantially. High flows during the nesting season that may cause localized nest failure would not increase. The impact on habitat for bank swallow nesting colonies, and therefore bank swallows themselves, would be less than significant.

There are seven known colonies of bank swallow along the Sacramento River in the primary study area (CNDDB 2012). The bank swallow forms nesting colonies in steep-cut, eroding river banks. Generally installed to protect upland land uses, bank revetment has been preferentially applied to actively migrating bends that otherwise would be among the most suitable sites for bank swallow nests. The reduction in intermediate to large flows by CP1 would cause a small reduction in the rate of erosion at the cut banks that remain unprotected by revetment. This alteration would not reduce the amount of bank swallow nesting habitat in the short or long term. As modeled, spring flows at Keswick Dam and Bend Bridge would be substantially reduced under some water year conditions (e.g., February and March of above-normal years, May of above-normal and below-normal years), but generally would remain within the ±2 percent threshold that is considered essentially equivalent to existing conditions (Table 13-22). Therefore, the potential for spring flows to cause localized bank swallow nest failure would remain comparable to existing and no-action conditions.

The rate of bank failure is not expected to change substantially, and nest failure caused by spring flows may be reduced under certain conditions. Therefore, the impact of CP1 on bank swallow would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Wild-19 (CP1): Disturbance or Removal of Vernal Pool Habitat for Special-Status Wildlife from Changes in Flow Regime Vernal pools are present in upland areas near the Sacramento River and its tributaries in the primary study area. These pools provide habitat for numerous special-status species, such as vernal pool tadpole shrimp, vernal pool fairy shrimp, and western spadefoot toad. Critical habitat for three special-status wildlife species (Conservancy fairy shrimp, vernal pool fairy shrimp, and vernal pool tadpole shrimp) is located within the primary study area. Critical habitat for these species in the primary study area is confined to vernal pool communities (USFWS 2006). However, vernal pools are generally not present within the active floodplain of the upper Sacramento River in the primary study area; thus, vernal pools are not anticipated to be affected by changes in flows that could result from implementation of CP1. Changes in flow regime in the primary study area likely would not affect vernal pool special-status species. Because CP1 would not affect vernal pool habitat or the species that occur within the habitat, no impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact Wild-20 (CP1): Consistency with Local and Regional Plans with Goals of Promoting Riparian Habitat in the Primary Study Area Several conservation and management plans have been adopted in the primary and extended study areas with goals of promoting riparian habitat along the Sacramento River. Because flow regimes and riverine geomorphic processes could be altered with project implementation, riparian habitat could be affected in such a manner that the goals of the local and regional plans would be more difficult to attain. Therefore, this impact would be potentially significant.

Several local and regional plans have been developed and adopted to promote conservation and enhancement of riparian habitat in the primary and extended study areas. Examples of these include the RHJV, Sacramento River Advisory Council Forum, Sacramento River Conservation Area Program, and SRNWR comprehensive conservation plan and environmental assessment (See Section 13.2, “Regulatory Setting.”)

Because CP1 may have a potentially significant impact on riparian vegetation in the primary and extended study areas, the quality of riparian habitat may be reduced or distribution may be limited. This potential consequence of the project could conflict with the goals developed in local and regional conservation plans for the Sacramento River. This impact would be potentially significant. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-21 (CP1): Impacts on Riparian-Associated Special-Status Wildlife Resulting from the Gravel Augmentation Program Gravel augmentation is not included as part of CP1. Therefore, no impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact Wild-22 (CP1): Impacts on Riparian-Associated Special-Status Wildlife Species Resulting from Restoration Projects CP1 would not include any specific restoration components. Therefore, no impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta By altering storage and operations at several reservoirs, CP1 would change flow regimes in several downstream waterways. In turn, these alterations to the flow regime could particularly affect riparian and wetland habitats along these waterways. The potential effects on wildlife are similar to those discussed for the primary study area above. However, potential effects on flow and stages of the middle Sacramento River would be smaller than those for the upper Sacramento River; changes in flows and stages would diminish downstream from Red Bluff because of the effects of inflows from tributaries, and the effects of diversions and flood bypasses.

Impact Wild-23 (CP1): Impacts on Riparian-Associated and Aquatic Special-Status Wildlife Resulting from Modifications to Existing Flow Regimes in the Lower Sacramento River and Delta Implementing CP1 would modify the flow regime and would reduce the frequency, duration, and magnitude of intermediate to large flows in the lower Sacramento River during winter and spring in some years. It also would increase flow volumes in fall of most years. This change in surface and subsurface hydrology would be of a smaller magnitude than in the upper Sacramento River, but could affect habitats adjacent to the river channel and the long-term formation of off-channel habitats along the lower Sacramento River, which would adversely affect the habitat of western pond turtle. Although the total amount of riparian vegetation would not decline substantially, the portion in early successional stages would be reduced. These early successional stages provide habitat for some special-status wildlife species. These changes could result in substantial effects on the distribution or abundance of riparian-nesting special-status bird species. Because CP1 would substantially alter habitat for a variety of riparian-dependent special-status species, this impact would be potentially significant.

This impact would be similar to Impact Wild-17 (CP1) for the upper Sacramento River. However, the effect of CP1 on flow in the Sacramento River would generally attenuate downstream from Red Bluff Pumping Plant because of the inflows from tributaries, and because of other diversions and flood bypasses. CalSim-II modeling indicates that in most months and under most types of water years, changes in flows from Bend Bridge downstream would be within the ±2 percent to be considered essentially equivalent to existing conditions (Table 13-22). The exceptions to this are in September of dry and critical water years, for which the model predicts substantial flow increases. Nonetheless, along the middle Sacramento River, flow alterations could be sufficient to substantially affect habitat of western pond turtle and riparian-nesting birds as described for the upper Sacramento River (Impact Wild-17 (CP1)). This impact would be potentially significant.

Flow alterations may not be sufficient to measurably affect special-status wildlife in the bypasses, along the Sacramento River downstream from Colusa, or in the Delta, for several reasons:

- Flow alterations are more attenuated downstream by tributaries, diversions, and bypasses, and the results of CalSim-II modeling indicate little change in the frequency and duration of bypass inundation.

- Downstream from Colusa, the river is confined to a narrow channel closely bordered by levees lined with riprap; thus, geomorphic processes and riparian habitats are relatively unresponsive to small changes in river flows.

The effects of flow alterations are unlikely to extend to the Delta because the Central Valley's reservoirs and diversions are managed as a single integrated system (consisting of the CVP and SWP). The CVP and SWP are managed to maintain standards for Delta inflow. CVP and SWP operations are constrained by USFWS's 2008 Formal ESA Consultation on the Proposed Coordinated

Operations of the CVP and SWP (2008 USFWS BO) and NMFS's 2009 BO and Conference Opinion on the Long-Term Operations of the CVP and SWP (2009 NMFS BO).

Thus, implementation of CP1 is not anticipated to cause an alteration in Sacramento River flow to the Delta sufficient to alter habitat for special-status wildlife species in the lower Sacramento River and Delta portion of the extended study area. However, because of the potential for substantial effects on western pond turtle and riparian-nesting birds in the lower Sacramento River (i.e., Red Bluff Pumping Plant to Colusa), this impact would be potentially significant. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-24 (CP1): Impacts on Bank Swallow Along the Lower Sacramento River Resulting from Modifications of Geomorphic Processes Implementing CP1 would cause a small reduction in the magnitude, duration, and frequency of intermediate to large flows in the lower Sacramento River. This reduction also would alter the river's geomorphic processes. The rate of bank erosion would be reduced, but the length of eroding banks would not be substantially altered, and thus, nesting habitat for bank swallows would not decline substantially. High flows during the nesting season that may cause localized bank and nest failure would not increase. The impact on habitat for bank swallow nesting colonies, and therefore bank swallows themselves, would be less than significant.

There are more than 100 presumed extant colonies of bank swallow in Butte, Glenn, Colusa, Yuba, Yolo, Sutter, and Sacramento counties (CNDDB 2012). The effect of CP1 on bank swallow along the lower Sacramento River would be similar to that described for the upper Sacramento River. There would be a small reduction in the rate of bank erosion, but not a substantial change in the amount of bank swallow nesting habitat, or increases in spring flows that may cause a substantial increase in localized nest failure. However, the effect of altered flow regimes on bank swallow nesting habitat along the lower Sacramento River would be smaller than the effect along the upper Sacramento River (described in Impact Wild-18 (CP1)). Flow alterations in the Sacramento River downstream from Red Bluff Pumping Plant would be attenuated by tributary inflow, and by other diversions and flood bypasses that would also alter instream flows. For these reasons, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Wild-25 (CP1): Disturbance or Removal of Vernal Pool Habitat for Special-Status Wildlife Along the Lower Sacramento River and in the Delta from Changes in Flow Regime of the Sacramento River and Affected Tributaries, and Changes in Seasonal Water Availability Vernal pools are present in upland areas near the Sacramento River and its tributaries in the extended study area. These pools provide habitat for numerous special-status species. Critical habitat for three special-status species (vernal pool fairy shrimp, vernal pool tadpole shrimp, and Conservancy fairy shrimp) is located within the extended study area. Critical habitat for these species is confined to vernal pool communities (USFWS 2006). However, vernal pools are generally not present within the active floodplain of regulated rivers along the lower Sacramento River and in the Delta. The largest increase in water surface elevation predicted to occur under CP1 for locations in the lower river is about 4 inches at Verona in September of dry water years. This increase would not result in river inundation of vernal pool habitat. Because all of the other predicted increases in water surface elevation are less than this, vernal pool special-status species would not likely be affected by changes in flow regime in the extended study area. Because CP1 would not affect vernal pool habitat or the species that occur within the habitat, no impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact Wild-26 (CP1): Consistency with Local and Regional Plans with Goals of Promoting Riparian Habitat Along the Lower Sacramento River and in the Delta Several conservation and management plans have been adopted in the primary and extended study areas with goals of promoting riparian habitat along the Sacramento River. Because flow regimes and riverine geomorphic processes could be altered with project implementation, riparian habitat could be affected in such a manner that the goals of the local and regional plans would be more difficult to attain. Therefore, this impact would be potentially significant.

This impact is similar to Impact Wild-20 (CP1) for the upper Sacramento River. For the same reasons as described for the upper Sacramento River, this impact would be potentially significant. Mitigation for this impact is proposed in Section 13.3.5.

CVP/SWP Service Areas Increased water supplies or increased supply reliability could reduce a limitation on growth or on other activities that could affect wildlife in the primary and extended study areas, potentially resulting in significant effects. The effects of this growth would be analyzed in general plan EIRs and in project-level CEQA compliance documents for the local jurisdictions in which the growth would occur. Mitigation of these effects would be the responsibility of these local jurisdictions, and not of Reclamation.

The expected increase in water deliveries relative to the entire CVP/SWP service areas would be small, however. Assuming that this increased deliveries could be provided to any number of geographic areas within the CVP and SWP service areas, the project's impact on growth that could affect wildlife habitat for sensitive species would be minor. Similarly, projects potentially affecting sensitive habitats and listed species would require permits from CDFW, USACE, and USFWS; it is anticipated that effects on these resources would be avoided, minimized, and/or mitigated during those agency consultations. Because the extent, location, and timing of induced growth is currently highly uncertain, and in the future the effects of this growth would be analyzed and mitigated during land use planning and environmental review for specific projects, growth-inducing effects on wildlife are not discussed further in this chapter. However, additional discussion of growth-inducing effects specific to the project alternatives is provided in Section 26.4, "Growth-Inducing Impacts," in Chapter 26, "Other Required Disclosures."

Impact Wild-27 (CP1): Impacts on Riparian-Associated or Aquatic Special-Status Wildlife in the CVP/SWP Service Areas Resulting from Modifications to Existing Flow Regimes By altering storage and operations at several reservoirs associated with the CVP and SWP service areas, CP1 would change flow regimes in several downstream waterways. Modified flow regimes would reduce the frequency, duration, and magnitude of intermediate to large flows along the Sacramento River. The change in surface and subsurface hydrology could affect habitats adjacent to the river channel that provide habitat for special-status wildlife species. These changes are unlikely to result in substantial effects on the distribution or abundance of riparian-associated or aquatic special-status wildlife species in the CVP and SWP service areas outside of the primary study area. Therefore, this impact would be less than significant.

Several riparian-associated or aquatic special-status wildlife species may be present in the CVP and SWP service areas, such as least Bell's vireo and arroyo toad. As discussed for the upper Sacramento River and the lower Sacramento River and Delta under Impact Wild-17 (CP1) and Impact Wild-21 (CP1), respectively, construction and operation of Shasta Dam has limited the frequency and magnitude of intermediate to large flows in winter and spring, and has increased flow volumes during the active growing season (primarily March–October). Implementation of CP1 would be expected to amplify these effects.

However, the effect of project-related alteration of flow regimes would attenuate somewhat in the Sacramento River downstream from Red Bluff Pumping Plant because of the inflows from tributaries, and because of other diversions and flood bypasses. Effects of flow alterations from Shasta Dam are also unlikely to extend to the CVP and SWP service areas because the reservoirs and diversions are managed as a single integrated system (consisting of the CVP and SWP). The CVP and SWP are managed to maintain standards for Delta inflow. CVP and SWP operations are constrained by the 2008 USFWS BO and NMFS's 2009 BO. Thus, this project is not anticipated to sufficiently alter flow to the CVP/SWP service areas to have a substantial effect on riparian habitat upon which special-status wildlife species depend. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

Like CP1, this comprehensive plan focuses on enlarging Shasta Dam and Shasta Lake consistent with the goals of the 2000 CALFED Programmatic ROD, and was formulated for the primary purposes of increased water supply reliability and increased survival of anadromous fish. In addition to the common features above, CP2 involves raising Shasta Dam 12.5 feet, an elevation change that would raise the full pool by 14.5 feet (6 feet higher than under CP1) and would enlarge the total storage space in the reservoir by 443,000 acre-feet.

With respect to wildlife impacts, dam construction activities for CP1 through CP5 would be so similar that they are considered to be identical for purposes of this analysis. Because CP2 would result in higher lake levels than CP1, CP2 would also require more relocation of utilities, public service facilities, and recreational facilities than CP1, including a loss of up to 35 acres of limestone habitat and 2,870 acres of nonlimestone habitat. Because CP2 would result in higher lake levels than CP1, CP2 would also result in a larger (and deeper) area of inundation than CP1, in turn requiring more vegetation clearing within the inundation area than CP1.

Shasta Lake and Vicinity

Impact Wild-1 (CP2): Take and Loss of Habitat for the Shasta Salamander Ground-disturbing activities associated with construction could result in direct take of the Shasta salamander, a State-listed species, USFS sensitive species, S&M species, MSCS-covered species, and BLM sensitive species. In addition, the raising of Shasta Dam would result in the inundation of habitat for this species. This impact would be significant.

Impacts caused by construction and vegetation clearing for the dam and relocation areas would be similar to CP1. However, inundation caused by a 12.5-foot raise of Shasta Dam would result in a greater loss of suitable habitat for the Shasta salamander. This impact would be significant.

Inundation resulting from a 12.5-foot dam raise would result in a loss of approximately 10 acres of limestone habitat and 1,668 acres of nonlimestone habitat. Impacts to limestone and nonlimestone habitats in the impoundment area are summarized in Table 13-23

Mitigation for this impact is proposed in Section 13.3.5.

Table 13-23. Impacts on Suitable Habitat for the Shasta Salamander in the Impoundment Area (12.5-Foot Dam Raise)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Limestone	0.00	1.14	0.00	7.64	0.00	2.06	10.83
Nonlimestone	309.64	59.64	485.89	282.19	170.34	360.68	1668.38
Total	309.64	60.78	485.89	289.83	170.34	362.74	1679.21

Note:
[1] Acreage values are approximate.

Impact Wild-2 (CP2): Impact on the Foothill Yellow-Legged Frog and Tailed Frog and Their Habitat Ground-disturbing activities associated with construction could result in direct take (e.g., because of operation of equipment in or adjacent to riverine or riparian habitat) of the foothill yellow-legged frog, a California species of special concern, a USFS sensitive species, an MSCS-covered species, and a BLM sensitive species, and of the tailed frog, a California species of special concern. In addition, the raising of Shasta Dam would result in the conversion of suitable riverine and riparian habitat to unsuitable lacustrine habitat. This impact would be potentially significant.

Impacts caused by construction and vegetation clearing for the dam and relocation areas would be similar to CP1. However, inundation caused by a 12.5-foot raise of Shasta Dam would result in a greater loss of suitable habitat for the foothill yellow-legged and tailed frogs. This impact would be potentially significant.

Implementation of a 12.5-foot raise of the dam would result in inundation of approximately 47 acres of habitat for the foothill yellow-legged frog and tailed frog. A summary of suitable habitat loss by arm is presented in Table 13-24.

Mitigation for this impact is proposed in Section 13.3.5.

Table 13-24. Impacts on Suitable Habitat for the Foothill Yellow-Legged and Tailed Frog in the Impoundment Area (12.5-Foot Dam Raise)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Montane riparian	2.72	3.23	20.57	6.12	1.00	3.62	37.26
Riverine	0.00	0.42	4.02	4.51	0.84	0.00	9.80
Total	2.72	3.65	24.59	10.63	1.84	3.62	47.05

Note:
[1] Acreage values are approximate.

Impact Wild-3 (CP2): Impact on the Northwestern Pond Turtle and Its Habitat Ground-disturbing activities associated with construction could result in direct take (e.g., because of operation of equipment in or adjacent to riverine or riparian habitat) of the northwestern pond turtle, an MSCS-covered species, a California species of special concern, and a USFS sensitive species. In addition, project implementation could result in the degradation of suitable aquatic habitat because of increased erosion and sedimentation. This impact would be potentially significant.

Impacts caused by construction and vegetation clearing for the dam and relocation areas would be similar to CP1. However, inundation caused by a 12.5-foot raise of Shasta Dam would result in a greater loss of suitable habitat for the northwestern pond turtle. This impact would be potentially significant.

Implementation of a 12.5-foot raise of the dam would result in conversion of approximately 37 acres of montane riparian and approximately 10 acres of riverine habitat to lacustrine habitat. Because there are equally valuable components lost or gained in either habitat, the quality of the habitat would not be compromised. However, maximum lake inundation would be infrequent (at most 1 month per year) and would not benefit the species throughout the remainder of the year. Thus, the conversion to lacustrine remains an impact on northwestern pond turtle habitat. A summary of suitable habitat loss by arm is presented in Table 13-25.

Mitigation for this impact is proposed in Section 13.3.5.

Table 13-25. Impacts on Suitable Habitat for the Northwestern Pond Turtle in the Impoundment Area (12.5-Foot Dam Raise)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Montane riparian	2.72	3.23	20.57	6.12	1.00	3.62	37.26
Riverine	0.00	0.42	4.02	4.51	0.84	0.00	9.80
Total	2.72	3.65	24.59	10.63	1.84	3.62	47.05

Note:
[1] Acreage values are approximate.

Impact Wild-4 (CP2): Impact on the American Peregrine Falcon Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas during the nesting season could result in the incidental loss of fertile eggs or nestlings or otherwise lead to the abandonment of nests of American peregrine falcons, a State fully protected species and MSCS-covered species. This impact would be potentially significant.

Impacts caused by construction and vegetation clearing for the dam and relocation areas would be similar to CP1. However, inundation caused by a 12.5-foot raise of Shasta Dam would result in a greater loss of suitable habitat for the American peregrine falcon.

Similar to CP1, overstory and complete vegetation removal is expected to occur within the impoundment area in suitable cliff habitat. Thus, overstory vegetation removal occurring in or near suitable cliff habitat during the nesting season could result in the incidental loss of fertile eggs or nestlings or otherwise lead to the abandonment of nests. Additionally, because of the steep terrain, trees would be yarded by helicopter. Noise generated by chainsaws and helicopter yarding could cause the abandonment of nests, resulting in the incidental loss of fertile eggs or nestlings. This impact would be potentially significant.

No known eyries would be inundated with a 12.5-foot raise in lake elevation; however, 12.5 vertical feet (full pool) of cliff habitat would be inundated. The impacts on this amount of cliff habitat suitable for nesting would be less than significant. The conversion of uplands to lacustrine habitat would not adversely affect foraging habitat for the species because they frequently forage over water. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-5 (CP2): Take and Loss of Habitat for the Bald Eagle
Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas in addition to inundation caused by the raising of Shasta Dam during the nesting season would result in the loss of nest and perch trees used by the bald eagle, a State-listed species, fully protected species, and USFS sensitive species, an MSCS-covered species, and a BLM sensitive species. This impact would be significant.

Impacts caused by construction and vegetation clearing for the dam and relocation areas would be similar to CP1. However, inundation caused by a 12.5-foot raise of Shasta Dam would result in a greater loss of suitable habitat for the bald eagle. This impact would be potentially significant.

Six known bald eagle nest trees would be affected by a 12.5-foot dam raise due to inundation. When inundation occurs, nest trees within the impoundment area would die. Because peak inundation generally occurs in late April or early June, nest trees would be flooded toward the end of the nesting season. If eagles were nesting in these trees, it would be likely that young would fledge before the nest tree died from the effects of inundation. Because of inundation timing, it is not likely that individuals would be affected. Because bald eagles generally use the same nest for multiple years, the loss of nest trees would be a significant impact.

Inundation could also affect erosion and bank stability, which could affect nest trees that are in close proximity to the impoundment area. This would be a potentially significant impact.

Inundation resulting from a 12.5-foot dam raise would result in a loss of approximately 1,376 acres of bald eagle nesting and roosting habitat. Impacts on suitable bald eagle habitat by CWHR type in the impoundment area are summarized in Table 13-26.

Mitigation for this impact is proposed in Section 13.3.5.

Table 13-26. Impacts on Suitable Habitat for the Bald Eagle in the Impoundment Area (12.5-Foot Dam Raise)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Blue oak woodland	0.00	0.00	0.00	0.00	0.00	3.03	3.03
Blue oak–foothill pine	7.05	0.00	0.00	0.00	2.46	22.80	32.31
Douglas-fir	0.00	0.00	0.00	0.06	0.00	0.00	0.06
Klamath mixed conifer	0.00	0.00	0.00	0.00	0.00	7.66	7.66
Montane hardwood	53.30	25.75	120.47	48.59	13.31	55.23	316.66
Montane hardwood–conifer	48.77	0.70	99.06	94.36	78.41	125.77	447.06
Montane riparian	2.72	3.23	20.57	6.12	1.00	3.62	37.26
Ponderosa pine	152.04	21.54	123.71	114.71	35.08	85.84	532.91
Total	263.88	51.21	363.82	263.88	130.26	303.95	1376.97

Note:
[1] Acreage values are approximate.

Impact Wild-6 (CP2): Loss of Dispersal Habitat for the Northern Spotted Owl
Construction activities and vegetation removal associated with the dam raise, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas would result in the loss of northern spotted owl dispersal habitat, a Federally listed as threatened species, and MSCS-covered species. This impact would be potentially significant.

Impacts caused by construction and vegetation clearing for the dam and relocation areas would be similar to CP1. However, inundation caused by a 12.5-foot raise of Shasta Dam would result in a greater loss of dispersal habitat for the northern spotted owl. This impact would be potentially significant.

Inundation resulting from a 12.5-foot dam raise would result in a loss of approximately 643 acres of dispersal habitat for the northern spotted owl. Impacts on suitable habitat for the spotted owl by CWHR type in the impoundment area are summarized in Table 13-27.

Mitigation for this impact is proposed in Section 13.3.5.

Table 13-27. Impacts on Suitable Habitat for the Northern Spotted Owl in the Impoundment Area (12.5-Foot Dam Raise)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Dispersal	96.85	10.29	155.97	157.79	77.74	144.87	643.51
Foraging	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nesting/roosting	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	96.85	10.29	155.97	157.79	77.74	144.87	643.51

Note:
[1] Acreage values are approximate.

Impact Wild-7 (CP2): Impact on the Purple Martin and Its Nesting Habitat
Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas during the nesting season could result in the incidental loss of fertile eggs or nestlings or otherwise lead to the abandonment of nests of purple martins, a California species of special concern. In addition, inundation caused by the raising of Shasta Dam would result in the loss of nest trees. This impact would be significant.

Impacts caused by construction and vegetation clearing for the dam and relocation areas would be similar to CP1. Also similar to CP1, nest trees occurring in the lake could be adversely affected by inundation and related vegetation removal. These impacts would be potentially significant.

Impact Wild-8 (CP2): Impacts on the Willow Flycatcher, Vaux's Swift, Yellow Warbler, and Yellow-Breasted Chat and Their Foraging and Nesting Habitat
Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas during the nesting season could result in the incidental loss of fertile eggs or nestlings or otherwise lead to the abandonment of nests of the willow flycatcher, which is State-listed as endangered, a USFS sensitive species, and an MSCS-covered species; the Vaux's swift, a California species of special concern; and the yellow warbler and yellow-breasted chat, both California species of special concern and MSCS-covered species. In addition, the raising of Shasta Dam would result in the loss of habitat, including nesting habitat, for these species. This impact would be potentially significant.

Impacts caused by construction and vegetation clearing for the dam and relocation areas would be similar to CP1. However, inundation caused by a 12.5-foot raise of Shasta Dam would result in a greater loss of suitable habitat for these species. This impact would be potentially significant.

Inundation resulting from a 12.5-foot dam raise would result in a loss of approximately 1,341 acres of Vaux's swift nesting and foraging habitat in the impoundment area. Additionally, approximately 37 acres of willow flycatcher, yellow warbler, and yellow-breasted chat habitat would be lost in the impoundment area.

Impacts on suitable habitats for the willow flycatcher, Vaux's swift, yellow warbler, and yellow-breasted chat habitat by CWHR type in the impoundment area is summarized in Table 13-28.

Mitigation for this impact is proposed in Section 13.3.5.

Table 13-28. Impacts on Suitable Habitat for the Willow Flycatcher, Vaux's Swift, Yellow Warbler, and Yellow-Breasted Chat in the Impoundment Area (12.5-Foot Dam Raise)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Vaux's Swift							
Douglas-fir	0.00	0.00	0.00	0.06	0.00	0.00	0.06
Klamath mixed conifer	0.00	0.00	0.00	0.00	0.00	7.66	7.66
Montane hardwood	53.30	25.75	120.48	48.59	13.31	55.23	316.66
Montane hardwood–conifer	48.77	0.70	99.06	94.36	78.41	125.77	447.07
Montane riparian	2.72	3.23	20.57	6.12	1.00	3.62	37.26
Ponderosa pine	152.04	21.54	123.71	114.71	35.08	85.84	532.91
Total Vaux's Swift Habitat	256.83	51.22	363.82	263.85	127.80	278.12	1,341.63
Willow Flycatcher, Yellow Warbler, and Yellow-Breasted Chat							
Montane riparian	2.72	3.23	20.57	6.12	1.00	3.62	37.26
Total Habitat	2.72	3.23	20.57	6.12	1.00	3.62	37.26

Note:
[1] Acreage values are approximate.

Impact Wild-9 (CP2): Impacts on the Long-Eared Owl, Northern Goshawk, Cooper's Hawk, Great Blue Heron, and Osprey and Their Foraging and Nesting Habitat Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas during the nesting season could result in the incidental loss of fertile eggs or nestlings or otherwise lead to the abandonment of nests of the long-eared owl, a California species of special concern and an MSCS-covered species; the northern goshawk, a California species of special concern, a USFS sensitive species, and a BLM sensitive species; Cooper's hawk, an MSCS-covered species; great blue heron, an MSCS-covered species; and osprey, an MSCS-covered species. In addition, the raising of Shasta Dam would result in the loss of foraging and nesting habitat for these species. This impact would be potentially significant.

Impacts caused by construction and vegetation clearing for the dam and relocation areas would be similar to CP1. However, inundation caused by a 12.5-foot raise of Shasta Dam would result in a greater loss of suitable habitat for these species. This impact would be potentially significant.

Inundation resulting from a 12.5-foot dam raise would result in a loss of approximately 987 acres of nesting and foraging habitat for long-eared owl and northern goshawk, approximately 1,505 acres of nesting and foraging habitat for the Cooper’s hawk, and approximately 1,505 acres of nesting habitat for the great blue heron. Foraging habitat would increase for osprey and great blue heron. No impact to foraging habitat for these species would occur.

Impacts on suitable habitat by CWHR type in the impoundment area are summarized in Table 13-29.

Impacts to osprey would be the same as described for CP1. There are 54 osprey nests within the perimeter of Shasta Lake. Six nest trees would be affected by a 12.5-foot dam raise and 11 nests are located in relocation areas. Removal of nest trees would be a potentially significant impact. Because osprey generally use the same nest for multiple years, the loss of 17 nest trees (31 percent of the total in the Shasta Lake and vicinity) between the impoundment area and relocation areas would be a potentially significant impact.

Mitigation for this impact is proposed in Section 13.3.5.

Table 13-29. Impacts on Suitable Habitat for the Long-Eared Owl, Northern Goshawk, Cooper’s Hawk, and Great Blue Heron in the Impoundment Area (12.5-Foot Dam Raise)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Long-Eared Owl and Northern Goshawk							
Douglas-fir	0.00	0.00	0.00	0.06	0.00	0.00	0.06
Klamath mixed conifer	0.00	0.00	0.00	0.00	0.00	7.66	7.66
Montane hardwood–conifer	48.77	0.70	99.06	94.36	78.41	125.77	447.07
Ponderosa pine	152.04	21.54	123.71	114.71	35.08	85.84	532.91
Total Habitat	200.81	22.23	222.77	209.13	113.49	219.27	987.70

Table 13-29. Impacts on Suitable Habitat for the Long-Eared Owl, Northern Goshawk, Cooper's Hawk, and Great Blue Heron in the Impoundment Area (12.5-Foot Dam Raise) (contd.)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Cooper's Hawk and Great Blue Heron							
Blue oak–foothill pine	7.05	0.00	0.00	0.00	2.46	22.80	32.31
Closed-cone pine-cypress	24.40	0.00	8.95	14.95	32.72	50.54	131.58
Douglas-fir	0.00	0.00	0.00	0.06	0.00	0.00	0.06
Klamath mixed conifer	0.00	0.00	0.00	0.00	0.00	7.66	7.66
Montane hardwood	53.30	25.75	120.48	48.59	13.31	55.23	316.66
Montane hardwood–conifer	48.77	0.70	99.06	94.36	78.41	125.77	447.07
Montane riparian	2.72	3.23	20.57	6.12	1.00	3.62	37.26
Ponderosa pine	152.04	21.54	123.71	114.71	35.08	85.84	532.91
Total Habitat	288.28	51.22	372.77	278.81	162.98	351.45	1505.51

Note:
[1] Acreage values are approximate.

Impact Wild-10 (CP2): Take and Loss of Habitat for the Pacific Fisher
Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas would result in a loss of habitat for the Pacific fisher, a Federal candidate for listing, a California species of special concern, a USFS sensitive species, and a BLM sensitive species. Furthermore, take (including mortality of individuals because of destruction or disturbance of active roost sites or dens) could result from construction activities and vegetation clearing. This impact would be potentially significant.

Impacts caused by construction and vegetation clearing for the dam and relocation areas would be similar to CP1. However, inundation caused by a 12.5-foot raise of Shasta Dam would result in a greater loss of suitable habitat for these species. This impact would be potentially significant.

Inundation resulting from a 12.5-foot dam raise would result in a loss of approximately 1,057 acres of Pacific fisher habitat.

Impacts on suitable habitat by CWHR type in the impoundment area are summarized in Table 13-30.

Mitigation for this impact is proposed in Section 13.3.5.

Table 13-30. Impacts on Suitable Habitat for the Pacific Fisher in the Impoundment Area (12.5-Foot Dam Raise)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Impoundment Area							
Blue oak-foothill pine	7.05	0.00	0.00	0.00	2.46	22.80	32.31
Douglas-fir	0.00	0.00	0.00	0.06	0.00	0.00	0.06
Klamath mixed conifer	0.00	0.00	0.00	0.00	0.00	7.66	7.66
Montane hardwood–conifer	48.77	0.70	99.06	94.36	78.41	125.77	447.06
Montane riparian	2.72	3.23	20.57	6.12	1.00	3.62	37.26
Ponderosa pine	152.04	21.54	123.71	114.71	35.08	85.84	532.91
Total Habitat	203.53	25.47	243.34	215.23	114.49	245.68	1057.27

Note:
[1] Acreage values are approximate.

Impact Wild-11 (CP2): Impacts on Special-Status Bats (Pallid Bat, Spotted Bat, Western Red Bat, Western Mastiff Bat, Townsend's Big-Eared Bat, Long-Eared Myotis, Yuma Myotis, and Fringed Myotis), the American Marten, and Ringtail and Their Habitat Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas would result in a loss of habitat for the pallid bat, a California species of special concern, a USFS sensitive species, and a BLM sensitive species; the western red bat, a USFS sensitive species; the western mastiff bat, a California species of special concern, an MSCS-covered species, and a BLM sensitive species; the Townsend's big-eared bat, a California species of special concern, a USFS sensitive species, and a BLM sensitive species; the long-eared myotis, a BLM sensitive species; the Yuma myotis, a BLM sensitive species; the fringed myotis, a USFS sensitive species; the American marten, a USFS sensitive species; and the ringtail, a State fully protected and MSCS-covered species. Furthermore, take (including mortality of individuals because of destruction or disturbance of active roost sites or dens) could result from construction activities and vegetation clearing. This impact would be potentially significant.

Impacts caused by construction and vegetation clearing for the dam and relocation areas would be similar to CP1. However, inundation caused by a 12.5-foot raise of Shasta Dam would result in a greater loss of suitable habitat for these species. This impact would be potentially significant.

Dam construction, vegetation removal, and construction in the relocation areas, and inundation resulting from a 12.5-foot dam raise would result in the loss of approximately 45 acres of reproductive and roosting habitat for the pallid bat, spotted bat, western mastiff bat, Townsend's big-eared bat, Yuma myotis, and fringed myotis in the impoundment area. Additionally, one limestone cave located on the Big Backbone Arm that is a known Townsend's big-eared bat roost would be affected by flooding. A 12.5-foot dam raise would result in the loss of approximately 1,687 acres of reproductive and roosting habitat for the western red bat and long-eared myotis. These impacts would be potentially significant.

Dam construction, vegetation removal, and inundation resulting from a 12.5-foot dam raise would result in the loss of approximately 1,687 acres of ringtail habitat. A 12.5-foot dam raise would result in the loss of approximately 1,022 acres of American marten habitat in the impoundment area. These impacts would be potentially significant.

Impacts on suitable habitat by CWHR type in the impoundment area are summarized in Table 13-31.

Mitigation for this impact is proposed in Section 13.3.5.

Table 13-31. Impacts on Suitable Habitat for Special-Status Bats, American Marten, and Ringtail in the Impoundment Area (12.5-Foot Dam Raise)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Impoundment Area							
Pallid Bat, Spotted Bat, Western Mastiff Bat, Townsend's Big-Eared Bat, Yuma Myotis, and Fringed Myotis							
Barren	1.40	0.89[1]	5.58	1.86	0.00	0.97	9.81
Blue oak woodland	0.00	0.00	0.00	0.00	0.00	3.03	3.03
Blue oak–foothill pine	7.05	0.00	0.00	0.00	2.46	22.80	32.31
Total	8.45	0.00	5.58	1.86	2.46	26.80	45.15
Western Red Bat, Long-Eared Myotis, and Ringtail							
Barren	1.40	0.00	5.58	1.86	0.00	0.96	9.81
Blue oak woodland	0.00	0.00	0.00	0.00	0.00	3.03	3.03
Blue oak–foothill pine	7.05	0.00	0.00	0.00	2.46	22.80	32.31
Closed-cone pine-cypress	24.40	0.00	8.95	14.95	32.72	50.53	131.58
Douglas-fir	0.00	0.00	0.00	0.06	0.00	0.00	0.06
Klamath mixed conifer	0.00	0.00	0.00	0.00	0.00	7.66	7.66
Mixed chaparral	20.58	9.56	112.76	11.02	7.35	8.26	169.54
Montane hardwood	53.30	25.75	120.48	48.54	13.31	55.23	316.66

Table 13-31. Impacts on Suitable Habitat for Special-Status Bats, American Marten, and Ringtail in the Impoundment Area (12.5-Foot Dam Raise) (contd.)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Montane hardwood–conifer	48.77	0.70	99.06	94.36	78.41	125.76	447.06
Montane riparian	2.72	3.23	20.57	6.12	1.00	3.62	37.26
Ponderosa pine	152.04	21.54	123.71	114.78	35.08	85.84	532.91
Total Habitat	310.27	60.78	491.12	291.69	170.34	363.71	1687.70
American Marten							
Douglas-fir	0.00	0.00	0.00	0.06	0.00	0.00	0.06
Klamath mixed conifer	0.00	0.00	0.00	0.00	0.00	4.70	4.70
Montane hardwood–conifer	48.77	0.70	99.06	94.36	78.41	125.77	447.06
Montane riparian	2.72	3.23	20.57	6.12	1.00	3.62	37.26
Ponderosa pine	152.03	21.54	123.71	114.71	35.08	85.84	532.91
Total Habitat	203.53	25.46	243.34	215.26	114.49	219.92	1022.00

Note:
[1] Acreage values are approximate.

Impact Wild-12 (CP2): Impacts on Special-Status Terrestrial Mollusks (Church's sideband, Shasta Sideband, Wintu Sideband, Oregon shoulderband, Shasta Chaparral, and Shasta Hesperian) and Their Habitat All of these species are designated USFS sensitive and/or S&M species, and the Shasta sideband is also an MSCS-covered species. The Shasta sideband, Wintu sideband, Shasta chaparral, and Shasta hesperian are also petitioned for Federal listing. Ground-disturbing activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas could result in direct take and/or loss of suitable habitat for special-status terrestrial mollusks. In addition, the raising of Shasta Dam would result in the inundation of suitable habitat and direct take of these species. This impact would be significant.

Impacts caused by construction and vegetation clearing for the dam and relocation areas would be similar to CP1. However, inundation caused by a 12.5-foot raise of Shasta Dam would result in a greater loss of suitable habitat for these species. This impact would be potentially significant.

Inundation resulting from a 12.5-foot dam raise would result in the loss of approximately 1,679 acres of Church's sideband, Oregon shoulderband, and Shasta chaparral habitat; and 37 acres of Shasta hesperian habitat in the impoundment area. Approximately 7 acres of Shasta sideband habitat and 2 acres of Wintu sideband would be lost. These impacts would be potentially significant.

Impacts on suitable habitat by CWHR type in the impoundment area are summarized in Table 13-32.

Mitigation for this impact is proposed in Section 13.3.5.

Table 13-32. Impacts on Suitable Habitat for Special-Status Terrestrial Mollusks in the Impoundment Area (12.5-Foot Dam Raise)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Impoundment Area: Shasta Sideband							
Limestone	0.00	0.00	0.00	7.64	0.00	0.00	7.64
Impoundment Area: Wintu Sideband							
Limestone	0.00	0.00	0.00	0.00	0.00	2.06	2.06
Impoundment Area: Church's sideband, Oregon shoulderband, Shasta Chaparral							
Barren	0.77	0.00	0.36	0.00	0.00	0.00	1.13
Blue oak woodland	0.00	0.00	0.00	0.00	0.00	3.03	3.03
Blue oak–foothill pine	7.05	0.00	0.00	0.00	2.46	22.80	32.31
Closed-cone pine–cypress	24.40	0.00	8.95	14.96	32.72	50.54	131.58
Douglas-fir	0.00	0.00	0.00	0.06	0.00	0.00	0.06
Klamath mixed conifer	0.00	0.00	0.00	0.00	0.00	7.66	7.66
Mixed chaparral	20.58	9.56	112.76	11.02	7.35	8.26	169.54
Montane hardwood	53.30	25.75	120.47	48.59	13.31	55.23	316.66
Montane hardwood–conifer	48.77	0.70	99.06	94.36	78.41	125.77	447.07
Montane riparian	2.72	3.23	20.57	6.12	1.00	3.62	37.26
Ponderosa pine	152.04	21.54	123.71	114.71	35.08	85.84	532.91
Total Habitat	310.00	60.78	485.89	289.83	170.34	362.74	1679.21
Impoundment Area: Shasta Hesperian							
Montane riparian	1.54	2.48	15.92	4.60	0.58	2.59	27.71
Total Habitat	1.54	2.48	15.92	4.60	0.58	2.59	27.71

Note:
[1] Acres are approximate.

Impact Wild-13 (CP2): Permanent Loss of General Wildlife Habitat and Western Bumble Bee Habitat Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas would result in a permanent loss of habitat. In addition, inundation caused by the raising of Shasta Dam would result in the permanent loss of habitat. This would be a potentially significant impact.

These general habitats also represent potential Western bumble bee habitat. Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas would result in a permanent loss of habitat containing flowering shrubs and forbs, which serve as potential Western bumble bee nectar sources, and potential underground burrow locations. In addition, inundation caused by the raising of Shasta Dam would result in the permanent loss of habitat. This would be a potentially significant impact.

Impacts caused by construction and vegetation clearing for the dam and relocation areas would be similar to CP1. However, inundation caused by a 12.5-foot raise of Shasta Dam would result in a greater loss of general wildlife habitat and Western bumble bee habitat. This impact would be potentially significant.

Inundation resulting from a 12.5-foot dam raise would result in a loss of approximately 1,725 acres of general wildlife habitat and Western bumble bee habitat in the impoundment area. Impacts on general wildlife habitat and Western bumble bee habitat by CWHR type in the impoundment area are summarized in Table 13-33.

Mitigation for this impact is proposed in Section 13.3.5.

Table 13-33. Impacts on CWHR Habitats and Western Bumble Bee Habitat in the Impoundment Area (12.5-Foot Dam Raise)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Annual grassland	0.36	0.00	1.53	0.53	0.00	0.38	2.79
Barren	1.40	0.00	5.58	1.86	0.00	0.97	9.81
Blue oak–foothill pine	7.05	0.00	0.00	0.00	2.46	22.79	32.31
Blue oak woodland	0.00	0.00	0.00	0.00	0.00	3.03	3.03
Closed-cone pine–cypress	24.40	0.00	8.95	14.96	32.72	50.54	131.58
Douglas-fir	0.00	0.00	0.00	0.06	0.00	0.00	0.06
Klamath mixed conifer	0.00	0.00	0.00	0.00	0.00	7.66	7.66
Mixed chaparral	20.58	9.56	112.76	11.02	7.35	8.26	169.54
Montane hardwood	53.30	25.75	120.48	48.59	13.31	55.23	316.66
Montane hardwood–conifer	48.77	0.70	99.06	94.36	78.41	125.77	447.06
Montane riparian	2.72	3.23	20.57	6.12	1.00	3.62	37.26
Ponderosa pine	152.04	21.54	123.71	114.71	35.08	85.84	532.91
Riverine	0.00	0.42	4.02	4.51	0.84	0.00	9.79

Table 13-33. Impacts on CWHR Habitats and Western Bumble Bee Habitat in the Impoundment Area (12.5-Foot Dam Raise) (contd.)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Urban	16.65	0.00	1.63	6.42	0.00	0.66	25.37
Total	327.28	61.20	498.30	303.14	171.18	364.75	1725.85

Note:
[1]Acreage values are approximate.

Impact Wild-14 (CP2): Impacts on Other Birds of Prey (e.g., red-tailed hawk and red-shouldered hawk) and Migratory Bird Species (e.g., American robin, Anna's hummingbird) and their Foraging and Nesting Habitat Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas during the nesting season could result in the incidental loss of fertile eggs or nestlings or otherwise lead to the abandonment of nests of other birds of prey and migratory bird species. In addition, inundation caused by the raising of Shasta Dam could result in the loss of active nests and habitat for these species. This impact would be potentially significant.

Impacts caused by construction and vegetation clearing for the dam and relocation areas would be similar to CP1. However, inundation caused by a 12.5-foot raise of Shasta Dam would result in greater impacts on nesting migratory birds and raptors. This impact would be potentially significant.

Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-15 (CP2): Loss of Critical Deer Winter and Fawning Range Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas would result in a loss of critical deer winter and fawning range. In addition, inundation caused by the raising of Shasta Dam would result in the loss of critical deer range. This would be a potentially significant impact.

Impacts caused by construction and vegetation clearing for the dam and relocation areas would be similar to CP1. However, inundation caused by a 12.5-foot raise of Shasta Dam would result in the loss of approximately 4,446 acres of critical deer winter and/or fawning range. This impact would be potentially significant. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-16 (CP2): Take and Loss of the California Red-Legged Frog Reclamation completed California red-legged frog habitat assessments in coordination with the USFWS in the applicable impoundment and relocation areas, and the potential downstream Sacramento River restoration sites. The assessment results will enable Reclamation and the USFWS to determine if habitat for the species occurs, if impacts are anticipated, and if additional surveys are needed. Impacts on the California red-legged frog will be assessed if surveys are conducted and the California red-legged frog is found. Impacts for each alternative will not be assessed until USFWS has determined whether suitable habitat is present and whether surveys would be required. Mitigation for this impact is discussed in Section 13.3.5.

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact Wild-17 (CP2): Impacts on Riparian-Associated Special-Status Wildlife Resulting from Modifications to the Existing Flow Regime in the Primary Study Area Implementing CP2 would increase available water storage in Shasta Reservoir and result in a modified flow regime. This modification would reduce the frequency, duration, and magnitude of intermediate to large flows downstream from Shasta Dam from December through January in most types of water years, extending through March in above-normal water years. Conversely, CP2 would increase the volume of flows from summer through fall of most years, especially in dry and critical water years. One of the goals of CP2 is to improve water supply during the driest of years, so this increase is not unexpected. This change in surface and subsurface hydrology could affect habitats adjacent to the river channel and reduce the long-term formation of off-channel habitats, which would adversely affect the habitat of western pond turtle. Although the total amount of riparian vegetation would not decline substantially, the portion in early successional stages would be reduced. These early successional stages provide habitat for some special-status wildlife species. These changes could result in substantial effects on the distribution or abundance of riparian-nesting special-status bird species. Because CP2 would substantially alter habitat for a variety of riparian-dependent special-status species, this impact would be potentially significant.

This impact would be similar to Impact Wild-17 (CP1). CP2 would affect habitat for sensitive species through the same pathways (alteration of off-channel habitat for western pond turtles, changes to successional patterns of vegetation) as discussed for CP1. The only difference between the two is the extent of the impact. Under CP2, the reductions in winter flows would be both more frequent and of larger magnitude than modeled to occur under CP1. In all water year types (except below-normal years and December of critical years), flows would be reduced by CP2 in December and January by on average about 2.2 and 8.0 percent. In above-normal years, this extends through February (-6.3 percent) and March (-5.2 percent) (Table 13-34). This impact would be potentially significant. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-18 (CP2): Impacts on Bank Swallow in the Primary Study Area Resulting from Modifications of Geomorphic Processes Implementing CP2 would cause a small reduction in the magnitude, duration, and frequency of intermediate to large flows in the Sacramento River in the primary study area. This reduction also would alter the river’s geomorphic processes, including the rate of bank erosion. However, the length of eroding banks would not be substantially altered, and thus, nesting habitat for bank swallows would not decline substantially. High flows during the nesting season that may cause localized nest failure would not increase substantially (generally less than an average of a 3-inch increase in water surface elevation in the worst case). For these reasons, the impact on habitat for bank swallow nesting colonies would be less than significant.

This impact would be similar to Impact Wild-18 (CP1). The extent of the impact could be greater under CP2 than under CP1 because reductions in channel-forming flows could be more extensive than under CP1. Nonetheless, for the same reasons as discussed for CP1, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Wild-19 (CP2): Disturbance or Removal of Vernal Pool Habitat for Special-Status Wildlife from Changes in Flow Regime As mentioned in Impact Wild-19 (CP1), vernal pools are generally not present within the active floodplain of the upper Sacramento River in the primary study area; vernal pools are found in upland locations outside of the main river channel and the floodplain. Thus, vernal pools are not anticipated to be affected by changes in flows that could result from implementation of CP2. Because CP2 would not affect vernal pool habitat or the species that occur within the habitat, no impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Table 13-34. Percent Change in Average Monthly Flows at Keswick Dam and Downstream Under CP2

Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Keswick												
Wet	1.2%	2.0%	-8.0%	-4.7%	-1.3%	0.4%	0.3%	0.4%	0.5%	0.5%	0.7%	0.9%
Above Normal	3.6%	0.0%	-2.5%	-2.2%	-6.3%	-5.2%	0.1%	-3.0%	-3.2%	0.3%	0.9%	8.6%
Below Normal	2.7%	-0.6%	-0.8%	-1.6%	-1.2%	-1.8%	0.5%	-4.0%	1.3%	0.1%	0.3%	1.3%
Dry	5.8%	5.3%	-2.8%	-3.3%	-0.6%	0.0%	1.8%	2.2%	3.9%	2.5%	4.9%	7.3%
Critical	3.6%	6.5%	1.5%	2.4%	1.6%	0.9%	0.9%	1.3%	0.8%	3.6%	-0.2%	9.4%
Bend Bridge												
Wet	1.1%	2.3%	-4.2%	-2.0%	-0.8%	0.3%	0.2%	0.4%	0.5%	0.4%	0.6%	0.8%
Above Normal	2.8%	-0.4%	-0.9%	-1.2%	-3.5%	-2.9%	0.1%	-2.0%	-2.4%	0.3%	0.8%	8.2%
Below Normal	2.4%	0.0%	-0.5%	-0.9%	-0.7%	-1.3%	0.4%	-2.6%	1.2%	0.1%	0.2%	1.2%
Dry	4.8%	4.6%	-1.5%	-1.6%	-0.3%	0.0%	1.4%	1.8%	3.7%	2.5%	4.8%	6.7%
Critical	2.7%	5.3%	1.3%	2.1%	1.4%	0.7%	0.8%	1.2%	0.7%	3.5%	-0.2%	8.6%
Butte City												
Wet	1.2%	3.0%	-3.2%	-1.2%	-0.5%	0.2%	0.2%	0.1%	0.3%	0.3%	0.6%	0.7%
Above Normal	3.3%	0.0%	-0.6%	-0.9%	-2.6%	-1.9%	0.2%	-2.6%	-2.8%	0.0%	0.7%	8.8%
Below Normal	2.5%	0.3%	-0.3%	-1.1%	-0.4%	-1.1%	-0.2%	-2.5%	1.6%	-0.1%	0.1%	0.9%
Dry	5.3%	5.0%	-1.1%	-1.0%	0.1%	-0.1%	2.2%	1.9%	5.3%	3.4%	6.6%	6.8%
Critical	2.5%	5.8%	1.3%	1.7%	1.3%	0.6%	1.1%	1.7%	1.0%	5.4%	-0.1%	8.6%
Wilkins Slough												
Wet	1.2%	3.2%	-2.0%	-0.5%	-0.1%	0.3%	0.2%	0.1%	0.3%	0.3%	0.6%	0.7%
Above Normal	3.3%	0.0%	-0.6%	-0.7%	-1.3%	-0.9%	0.2%	-2.6%	-2.8%	0.0%	0.7%	8.8%
Below Normal	2.5%	0.3%	0.0%	-1.1%	0.1%	-1.1%	-0.2%	-2.5%	1.6%	-0.1%	0.1%	0.9%
Dry	5.3%	5.0%	-1.1%	-0.9%	0.0%	-0.1%	2.2%	1.9%	5.3%	3.4%	6.6%	6.8%
Critical	2.5%	5.8%	1.3%	1.7%	1.3%	0.6%	1.1%	1.7%	1.0%	5.4%	-0.1%	8.6%
Verona												
Wet	0.4%	2.4%	-1.8%	-0.4%	-0.1%	0.2%	0.1%	0.0%	0.2%	0.0%	0.0%	0.4%
Above Normal	2.2%	0.7%	-0.5%	-0.4%	-1.7%	-0.5%	0.1%	-1.1%	-1.6%	0.0%	0.4%	3.5%
Below Normal	1.4%	1.0%	-0.5%	-0.4%	0.1%	-0.7%	-0.1%	-1.0%	1.6%	-0.1%	0.1%	-0.3%
Dry	3.2%	3.7%	-1.1%	-0.5%	-0.1%	0.0%	1.3%	1.0%	-1.5%	2.6%	3.4%	10.1%
Critical	0.7%	4.1%	0.8%	1.3%	0.8%	0.3%	0.7%	2.0%	1.2%	6.2%	-1.4%	5.4%

Table 13-34. Percent Change in Average Monthly Flows at Keswick Dam and Downstream Under CP2 (contd.)

Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Freeport												
Wet	0.4%	0.7%	-0.3%	-0.4%	0.1%	0.1%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
Above Normal	1.9%	-0.4%	-0.1%	0.2%	-0.4%	-0.4%	0.1%	-0.9%	-1.3%	-0.1%	0.1%	0.6%
Below Normal	0.4%	0.2%	0.3%	0.5%	0.2%	-0.5%	0.2%	-1.1%	0.4%	-0.3%	-0.4%	0.2%
Dry	2.3%	2.8%	-0.7%	-0.3%	0.1%	0.1%	1.0%	0.7%	-0.5%	1.7%	2.8%	8.0%
Critical	-0.1%	2.8%	1.0%	1.5%	0.7%	0.0%	0.7%	0.9%	0.0%	2.1%	0.6%	3.6%

Impact Wild-20 (CP2): Consistency with Local and Regional Plans with Goals of Promoting Riparian Habitat in the Primary Study Area Several conservation and management plans have been adopted in the primary and extended study areas with goals of promoting riparian habitat along the Sacramento River. Because flow regimes and riverine geomorphic processes could be altered with project implementation, riparian habitat could be affected in such a manner that the goals of the local and regional plans would be more difficult to attain. Therefore, this impact would be potentially significant.

This impact would be similar to Impact Wild-20 (CP1). The extent of the impact could be greater under CP2 than under CP1. This impact would be potentially significant. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-21 (CP2): Impacts on Riparian-Associated Special-Status Wildlife Resulting from the Gravel Augmentation Program Gravel augmentation is not included as part of CP2. Therefore, no impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact Wild-22 (CP2): Impacts on Riparian-Associated Special-Status Wildlife Species Resulting from Restoration Projects CP2 would not include any specific restoration components. Therefore, no impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta

Impact Wild-23 (CP2): Impacts on Riparian-Associated and Aquatic Special-Status Wildlife Resulting from Modifications to Existing Flow Regimes in the Lower Sacramento River and Delta Implementing CP2 would modify the flow regime and would reduce the frequency, duration, and magnitude of intermediate to large flows in the lower Sacramento River during winter in some years. It also would increase the flow volumes in late summer and fall of most years. Although this change in surface and subsurface hydrology would be of a smaller magnitude than in the upper Sacramento River, it could affect habitats adjacent to the river channel and the formation of off-channel habitats along the lower Sacramento River, which would adversely affect the habitat of western pond turtle. Although the total amount of riparian vegetation would not decline substantially, the portion in early successional stages would be reduced. These early successional stages provide habitat for some special-status wildlife species. These changes could result in substantial effects on the distribution or abundance of riparian-nesting special-status bird species. Because CP2 would substantially alter habitat for a variety of riparian-dependent special-status species, this impact would be potentially significant.

This impact would be similar to Impact Wild-23 (CP1). Because CP2 could substantially reduce available habitat for special-status wildlife, this impact would be potentially significant. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-24 (CP2): Impacts on Bank Swallow Along the Lower Sacramento River Resulting from Modifications of Geomorphic Processes Implementing CP2 would cause a small reduction in the magnitude, duration, and frequency of intermediate to large flows in the lower Sacramento River. This reduction also would alter the river's geomorphic processes. The rate of bank erosion would be reduced, but the length of eroding banks would not be substantially altered, and thus, nesting habitat for bank swallows would not decline substantially. High flows during the nesting season that may cause localized bank and nest failure would not increase substantially. The impact on habitat for bank swallow nesting colonies, and therefore bank swallows themselves, would be less than significant.

This impact would be similar to Impact Wild-24 (CP1). The effect of CP2 on bank swallow habitat along the lower Sacramento River would be similar to the effect along the upper Sacramento River, but smaller because the effect of CP2 on river flows would attenuate with distance downstream. Because the extent of bank erosion and flooding of nesting sites is not expected to substantially change under CP2, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Wild-25 (CP2): Disturbance or Removal of Vernal Pool Habitat for Special-Status Wildlife Along the Lower Sacramento River and in the Delta from Changes in Flow Regime of the Sacramento River and Affected Tributaries, and Changes in Seasonal Water Availability Vernal pools are present in upland areas near the Sacramento River and its tributaries in the extended study area. These pools provide habitat for numerous special-status species. Critical habitat for three special-status species (vernal pool fairy shrimp, vernal pool tadpole shrimp, and Conservancy fairy shrimp) is located within the extended study area. Critical habitat for these species is confined to vernal pool communities (USFWS 2006). However, vernal pools are generally not present within the active floodplain of regulated rivers along the lower Sacramento River and in the Delta. Because the sensitive habitat and species are located outside of the area affected by the changes in flows, CP2 would not alter this habitat. Therefore, no impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact Wild-26 (CP2): Consistency with Local and Regional Plans with Goals of Promoting Riparian Habitat Along the Lower Sacramento River and in the Delta Several conservation and management plans have been adopted in the primary and extended study areas with goals of promoting riparian habitat along the Sacramento River. Because flow regimes and riverine geomorphic processes could be altered with project implementation, riparian habitat could be affected in such a manner that the goals of the local and regional plans would be more difficult to attain. Therefore, this impact would be potentially significant.

This impact would be similar to Impact Wild-26 (CP1) and would be potentially significant. Mitigation for this impact is proposed in Section 13.3.5.

CVP/SWP Service Areas

Impact Wild-27 (CP2): Impacts on Riparian-Associated or Aquatic Special-Status Wildlife in the CVP/SWP Service Areas Resulting from Modifications to Existing Flow Regimes By altering storage and operations at several reservoirs associated with the CVP and SWP service areas, CP2 would change flow regimes in several downstream waterways. Modified flow regimes would reduce the frequency, duration, and magnitude of intermediate to large flows along the Sacramento River. The change in surface and subsurface hydrology could affect habitats adjacent to the river channel that provide habitat for special-status wildlife species. These changes are unlikely to result in substantial effects on the distribution or abundance of riparian-associated or aquatic special-status wildlife species in the CVP and SWP service areas outside of the primary study area. Therefore, this impact would be less than significant.

This impact would be similar to Impact Wild-27 (CP1). The CVP and SWP are operated as an integrated system with the same downstream management targets and goals. CVP and SWP operations are constrained by the 2008 USFWS BO and the 2009 NMFS BO. Thus, implementation of CP2 is not anticipated to sufficiently alter flow to the CVP/SWP service areas to have a substantial effect on the riparian habitat upon which special-status wildlife species depend. For these reasons, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CP3 – 18.5-Foot Dam Raise, Agricultural Water Supply Reliability and Anadromous Fish Survival

CP3 is similar to CP1 and CP2. It focuses on the greatest practical enlargement of Shasta Dam and Shasta Lake consistent with the goals of the 2000 CALFED Programmatic ROD, and was formulated for the primary purposes of increased water supply reliability and increased survival of anadromous fish. In addition to the common features above, CP3 involves raising Shasta Dam 18.5 feet, an elevation change that would increase the full pool by 20.5 feet and enlarge the total storage space in the reservoir by 634,000 acre-feet to 5.19 million acre-feet.

With respect to wildlife impacts, dam construction activities for CP1 through CP5 would be so similar that they are considered to be identical for purposes of this analysis. Because CP3 would result in higher lake levels than CP2, CP3 would also require more relocation of utilities, public service facilities, and recreational facilities than CP2, including a loss of up to 35 acres of limestone habitat and 2,870 acres of nonlimestone habitat. Because CP3 would result in higher lake levels than CP2, CP3 would also result in a larger (and deeper) area of inundation than CP2, in turn requiring more vegetation clearing within the inundation area than CP2.

Shasta Lake and Vicinity

Impact Wild-1 (CP3): Take and Loss of Habitat for the Shasta Salamander Ground-disturbing activities associated with construction could result in direct take of the Shasta salamander, a State-listed species, USFS sensitive species, S&M species, MSCS-covered species, and BLM sensitive species. In addition, the raising of Shasta Dam would result in the inundation of habitat for this species. This impact would be significant.

Impacts caused by construction and vegetation clearing for the dam and relocation areas would be similar to CP1. However, inundation caused by an 18.5-foot raise of Shasta Dam would result in a greater loss of suitable habitat for the Shasta salamander. This impact would be significant.

Inundation resulting from an 18.5-foot dam raise would result in a loss of approximately 16 acres of limestone habitat and 2,399 acres of nonlimestone habitat. Impacts on limestone and nonlimestone habitats in the impoundment area are summarized in Table 13-35.

Mitigation for this impact is proposed in Section 13.3.5.

Table 13-35. Impacts on Suitable Habitat for the Shasta Salamander in the Impoundment Area (18.5-Foot Dam Raise)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Limestone	0.00	1.63	0.00	11.09	0.00	2.85	15.57
Nonlimestone	436.74	89.15	710.35	407.76	241.51	511.00	2399.56
Total	436.74	90.78	710.35	418.85	241.51	513.85	2415.13

Note:
[1] Acreage values are approximate.

Impact Wild-2 (CP3): Impact on the Foothill Yellow-Legged Frog and Tailed Frog and Their Habitat Ground-disturbing activities associated with construction could result in direct take (e.g., because of operation of equipment in or adjacent to riverine or riparian habitat) of the foothill yellow-legged frog, a California species of special concern, a USFS sensitive species, an MSCS-covered species, and a BLM sensitive species, and of the tailed frog, a California species of special concern. In addition, the raising of Shasta Dam would result in the conversion of suitable riverine and riparian habitat to unsuitable lacustrine habitat. This impact would be potentially significant.

Impacts caused by construction and vegetation clearing for the dam and relocation areas would be similar to CP1. However, inundation caused by an 18.5-foot raise of Shasta Dam would result in a greater loss of suitable habitat for the foothill yellow-legged and tailed frogs. This impact would be potentially significant.

Implementation of an 18.5-foot raise of the dam would result in inundation of approximately 80 acres of foothill yellow-legged frog and tailed frog habitat. A summary of suitable habitat loss by arm is presented in Table 13-36.

Mitigation for this impact is proposed in Section 13.3.5.

Table 13-36. Impacts on Suitable Habitat for the Foothill Yellow-Legged and Tailed Frog in the Impoundment Area (18.5-Foot Dam Raise)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Montane riparian	4.16	6.67	26.16	13.91	1.53	5.52	57.94
Riverine	0.00	0.88	5.24	15.43	1.41	0.00	22.96
Total	4.16	7.55	31.40	29.34	2.94	5.52	80.90

Note:
[1] Acreage values are approximate.

Impact Wild-3 (CP3): Impact on the Northwestern Pond Turtle and Its Habitat
Ground-disturbing activities associated with construction could result in direct take (e.g., because of operation of equipment in or adjacent to riverine or riparian habitat) of the northwestern pond turtle, an MSCS-covered species, a California species of special concern, and a USFS sensitive species. In addition, project implementation could result in the degradation of suitable aquatic habitat because of increased erosion and sedimentation. This impact would be potentially significant.

Impacts caused by construction and vegetation clearing for the dam and relocation areas would be similar to CP1. However, inundation caused by an 18.5-foot raise of Shasta Dam would result in a greater loss of suitable habitat for the northwestern pond turtle. This impact would be potentially significant.

Implementation of an 18.5-foot raise of the dam would result in the conversion of approximately 58 acres of montane riparian and 23 acres of riverine habitat to lacustrine habitat. Because equally valuable components are lost or gained in either habitat, the quality of the habitat would not be compromised. However, maximum lake inundation would be infrequent (at most 1 month per year) and would not benefit the species throughout the remainder of the year. Thus, the conversion to lacustrine habitat would remain an impact on northwestern pond turtle habitat. A summary of suitable habitat loss by arm is presented in Table 13-37.

Mitigation for this impact is proposed in Section 13.3.5.

Table 13-37. Impacts on Suitable Habitat for the Northwestern Pond Turtle in the Impoundment Area (18.5-Foot Dam Raise)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Montane riparian	4.16	6.67	26.16	13.91	1.53	5.52	57.94
Riverine	0.00	0.88	5.24	15.43	1.41	0.00	22.96
Total	4.16	7.55	31.40	29.34	2.94	5.52	80.90

Note:
[1] Acreage values are approximate.

Impact Wild-4 (CP3): Impact on the American Peregrine Falcon Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas during the nesting season could result in the incidental loss of fertile eggs or nestlings or otherwise lead to the abandonment of nests of American peregrine falcons, a State fully protected species and MSCS-covered species. This impact would be potentially significant.

Impacts caused by construction and vegetation clearing for the dam and relocation areas would be similar to CP1. However, inundation caused by an 18.5-foot raise of Shasta Dam would result in a greater loss of suitable habitat for the American peregrine falcon.

Similar to CP1, overstory and complete vegetation removal is expected to occur within the impoundment area in suitable cliff habitat. Thus, overstory vegetation removal occurring in or near suitable cliff habitat during the nesting season could result in the incidental loss of fertile eggs or nestlings or otherwise lead to the abandonment of nests. Additionally, because of the steep terrain, trees would be yarded by helicopter. Noise generated by chainsaws and helicopter yarding could cause the abandonment of nests, resulting in the incidental loss of fertile eggs or nestlings. This impact would be potentially significant.

No known eyries would be inundated with an 18.5-foot raise in lake elevation; however, 18.5 (full pool) vertical feet of cliff habitat would be inundated. The impacts on this amount of cliff habitat suitable for nesting would be less than significant. The conversion of uplands to lacustrine habitat would not adversely affect foraging habitat for the species because they frequently forage over water. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-5 (CP3): Take and Loss of Habitat for the Bald Eagle Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas in addition to inundation caused by the raising of Shasta Dam during the nesting season would result in the loss of nest and perch trees used by the bald eagle, a State-listed species, fully protected species, and USFS sensitive species, an MSCS-covered species, and a BLM sensitive species. This impact would be significant.

Impacts caused by construction and vegetation clearing for the dam and relocation areas would be similar to CP1. However, inundation caused by an 18.5-foot raise of Shasta Dam would result in a greater loss of suitable habitat for the bald eagle. This impact would be potentially significant.

Six known bald eagle nest trees would be affected by an 18.5-foot dam raise due to inundation. When inundation occurs, nest trees within the impoundment area would die. Because peak inundation generally occurs in late April or early June, nest trees would be flooded toward the end of the nesting season. If eagles were nesting in these trees, it would be likely that young would fledge before the nest tree died from the effects of inundation. Because of inundation timing, it is not likely that individuals would be affected. Because bald eagles generally use the same nest for multiple years, the loss of nest trees would be a significant impact.

Inundation could also affect erosion and bank stability, which could affect nest trees that are in close proximity to the impoundment area. This would be a potentially significant impact.

Inundation resulting from an 18.5-foot dam raise would result in a loss of approximately 1,989 acres of bald eagle nesting and roosting habitat. Impacts on suitable bald eagle habitat by CWHR type in the impoundment area are summarized in Table 13-38.

Mitigation for this impact is proposed in Section 13.3.5.

Table 13-38. Impacts on Suitable Habitat for the Bald Eagle in the Impoundment Area (18.5-Foot Dam Raise)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Blue oak woodland	0.00	0.00	0.00	0.00	0.00	4.18	4.18
Blue oak–foothill pine	10.36	0.00	0.00	0.00	4.29	32.33	46.98
Douglas-fir	0.00	0.00	0.00	0.36	0.00	0.00	0.36
Klamath mixed conifer	0.00	0.00	0.00	0.00	0.00	10.96	10.96
Montane hardwood	73.49	38.76	171.02	70.36	19.43	78.84	451.91
Montane hardwood–conifer	70.68	0.99	150.43	136.53	111.63	179.48	649.76

Table 13-38. Impacts on Suitable Habitat for the Bald Eagle in the Impoundment Area (18.5-Foot Dam Raise) (contd.)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Montane riparian	4.16	6.67	26.16	13.91	1.53	5.52	57.94
Ponderosa pine	215.11	30.72	188.21	161.64	49.56	122.07	767.30
Total	373.80	77.15	535.81	382.82	186.44	433.38	1989.40

Note:
[1] Acreage values are approximate.

Impact Wild-6 (CP3): Loss of Dispersal Habitat for the Northern Spotted Owl
Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas during the nesting season could result in the incidental loss of fertile eggs or nestlings or otherwise lead to the abandonment of nests of the northern spotted owl, a species that is Federally listed as threatened species and an MSCS-covered species. In addition, inundation caused by the raising of Shasta Dam would result in the loss of habitat for this species. This impact would be potentially significant.

Impacts caused by construction and vegetation clearing for the dam and relocation areas would be similar to CP1. However, inundation caused by an 18.5-foot raise of Shasta Dam would result in a greater loss of suitable habitat for the northern spotted owl. This impact would be potentially significant.

Inundation resulting from an 18.5-foot dam raise would result in a loss of approximately 976 acres of northern spotted owl dispersal habitat. Impacts on suitable spotted owl habitat by CWHR type in the impoundment area are summarized in Table 13-39.

Mitigation for this impact is proposed in Section 13.3.5.

Table 13-39. Impacts on Suitable Habitat for the Northern Spotted Owl in the Impoundment Area (18.5-Foot Dam Raise)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Dispersal	145.16	17.49	243.53	239.73	114.12	216.06	976.09
Foraging	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nesting/Roosting	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	145.16	17.49	243.53	239.73	114.12	216.06	976.09

Note:
[1] Acreage values are approximate.

Impact Wild-7 (CP3): Impact on the Purple Martin and Its Nesting Habitat
Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas during the nesting season could result in the incidental loss of fertile eggs or nestlings or otherwise lead to the abandonment of nests of purple martins, a California species of special concern. In addition, inundation caused by the raising of Shasta Dam would result in the loss of nest trees. This impact would be significant.

Impacts caused by construction and vegetation clearing for the dam and relocation areas would be similar to CP1. Also similar to CP1, nest trees occurring in the lake could be adversely affected by inundation and related vegetation removal. These impacts would be potentially significant.

Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-8 (CP3): Impacts on the Willow Flycatcher, Vaux's Swift, Yellow Warbler, and Yellow-Breasted Chat and Their Foraging and Nesting Habitat
Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas during the nesting season could result in the incidental loss of fertile eggs or nestlings or otherwise lead to the abandonment of nests of the willow flycatcher, a species State listed as endangered, a USFS sensitive species, and an MSCS-covered species; the Vaux's swift, a California species of special concern; and the yellow warbler and yellow-breasted chat, both California species of special concern and MSCS-covered species. In addition, the raising of Shasta Dam would result in the loss of habitat, including nesting habitat, for these species. This impact would be potentially significant.

Impacts caused by construction and vegetation clearing for the dam and relocation areas would be similar to CP1. However, inundation caused by an 18.5-foot raise of Shasta Dam would result in a greater loss of suitable habitat for these species. This impact would be potentially significant.

Inundation resulting from an 18.5-foot dam raise would result in a loss of approximately 1,938 acres of Vaux's swift nesting and foraging habitat in the impoundment area. Additionally, approximately 58 acres of willow flycatcher, yellow warbler, and yellow-breasted chat habitat would be lost in the impoundment area.

Impacts on suitable habitats for the willow flycatcher, Vaux's swift, yellow warbler, and yellow-breasted chat by CWHR type in the impoundment area are summarized in Table 13-40.

Mitigation for this impact is proposed in Section 13.3.5.

Table 13-40. Impacts on Suitable Habitat for the Vaux's Swift, Yellow Warbler, and Yellow-Breasted Chat in the Impoundment Area (18.5-Foot Dam Raise)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Impoundment Area							
Vaux's Swift							
Douglas-fir	0.00	0.00	0.00	0.36	0.00	0.00	0.36
Klamath mixed conifer	0.00	0.00	0.00	0.00	0.00	10.96	10.96
Montane hardwood	73.49	38.76	171.01	70.36	19.43	78.84	451.91
Montane hardwood–conifer	70.68	0.99	150.43	136.54	111.63	179.48	649.76
Montane riparian	4.16	6.67	26.16	13.91	1.53	5.52	57.94
Ponderosa pine	215.11	30.72	188.20	161.64	49.56	122.07	767.30
Total Vaux's Swift Habitat	363.44	77.14	535.81	382.82	182.15	396.86	1938.24
Willow Flycatcher, Yellow Warbler, and Yellow-Breasted Chat							
Montane riparian	4.16	6.67	26.16	13.91	1.53	5.52	57.94
Total Habitat	4.16	6.67	26.16	13.91	1.53	5.52	57.94

Note:
[1] Acreage values are approximate.

Impact Wild-9 (CP3): Impacts on the Long-Eared Owl, Northern Goshawk, Cooper's Hawk, Great Blue Heron, and Osprey and Their Foraging and Nesting Habitat Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas during the nesting season could result in the incidental loss of fertile eggs or nestlings or otherwise lead to the abandonment of nests of the long-eared owl, a California species of special concern and an MSCS-covered species; the northern goshawk, a California species of special concern, a USFS sensitive species, and a BLM sensitive species; the Cooper's hawk, an MSCS-covered species; the great blue heron, an MSCS-covered species; and the osprey, an MSCS-covered species. In addition, the raising of Shasta Dam would result in the loss of foraging and habitat for these species. This impact would be potentially significant.

Impacts caused by construction and vegetation clearing for the dam and relocation areas would be similar to CP1. However, inundation caused by an 18.5-foot raise of Shasta Dam would result in a greater loss of suitable habitat for these species. This impact would be potentially significant.

Inundation resulting from an 18.5-foot dam raise would result in a loss of approximately 1,428 acres of nesting and foraging habitat for the long-eared owl and northern goshawk, approximately 2,167 acres of nesting and foraging habitat for the Cooper's hawk, and approximately 2,167 acres of nesting habitat for the great blue heron. Foraging habitat would increase for osprey and the great blue heron. No impact to foraging habitat for these species would occur.

Impacts on suitable habitat by CWHR type in the impoundment area are summarized in Table 13-41.

Table 13-41. Impacts on Suitable Habitat for the Long-Eared Owl, Northern Goshawk, Cooper's Hawk, and Great Blue Heron in the Impoundment Area (18.5-Foot Dam Raise)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Long-Eared Owl and Northern Goshawk							
Douglas-fir	0.00	0.00	0.00	0.36	0.00	0.00	0.36
Klamath mixed conifer	0.00	0.00	0.00	0.00	0.00	10.96	10.96
Montane hardwood–conifer	70.68	0.99	150.43	136.54	111.63	179.48	649.76
Ponderosa pine	215.11	30.72	188.21	161.64	49.56	122.07	767.30
Total Habitat	285.80	31.72	338.61	298.36	161.19	312.51	1428.39
Cooper's Hawk and Great Blue Heron							
Blue oak–foothill pine	10.36	0.00	0.00	0.00	4.29	32.33	46.98
Closed-cone pine-cypress	32.68	0.00	12.95	20.89	44.72	70.52	181.77
Douglas-fir	0.00	0.00	0.00	0.36	0.00	0.00	0.36
Klamath mixed conifer	0.00	0.00	0.00	0.00	0.00	10.96	10.96
Montane hardwood	73.49	38.76	171.02	70.55	19.43	78.84	451.91
Montane hardwood–conifer	70.68	0.99	150.43	136.54	111.63	179.48	649.76
Montane riparian	4.16	6.67	26.16	13.91	1.53	5.52	57.94
Ponderosa pine	215.11	30.72	188.21	161.63	49.56	122.06	767.30
Total Habitat	406.48	77.15	548.77	403.70	231.16	499.73	2167.00

Note:
[1] Acreage values are approximate.

Impacts to osprey would be similar to those described for CP1. There are 54 osprey nests within the perimeter of Shasta Lake. Seven nest trees would be affected by a 12.5-foot dam raise, and 11 nests are located in relocation areas. Removal of nest trees would be a potentially significant impact. Because osprey generally use the same nest for multiple years, the loss of 18 nest trees (33 percent of the total in the Shasta Lake and vicinity) between the impoundment area and relocation areas would be a potentially significant impact.

Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-10 (CP3): Take and Loss of Habitat for the Pacific Fisher
Construction activities and vegetation removal associated with raising the dam,

construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas would result in a loss of habitat for the Pacific fisher, a Federal candidate for listing, a California species of special concern, a USFS sensitive species, and a BLM sensitive species. Furthermore, take (including mortality of individuals because of destruction or disturbance of active roost sites or dens) could result from construction activities and vegetation clearing. This impact would be potentially significant.

Impacts caused by construction and vegetation clearing for the dam and relocation areas would be similar to CP1. However, inundation caused by an 18.5-foot raise of Shasta Dam would result in a greater loss of suitable habitat for these species. This impact would be potentially significant.

Inundation resulting from an 18.5-foot dam raise would result in a loss of approximately 1,533 acres of Pacific fisher habitat.

Impacts on suitable habitat by CWHR type in the impoundment area are summarized in Table 13-42.

Mitigation for this impact is proposed in Section 13.3.5.

Table 13-42. Impacts on Suitable Habitat for the Pacific Fisher in the Impoundment Area (18.5-Foot Dam Raise)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Blue oak-foothill pine	10.36	0.00	0.00	0.00	4.29	32.33	46.98
Douglas-fir	0.00	0.00	0.00	0.36	0.00	0.00	0.36
Klamath mixed conifer	0.00	0.00	0.00	0.00	0.00	10.96	10.96
Montane hardwood–conifer	70.68	0.99	150.43	136.53	111.63	179.48	649.76
Montane riparian	4.16	6.67	26.16	13.91	1.53	5.52	57.94
Ponderosa pine	215.11	30.72	188.21	161.64	49.56	122.07	767.30
Total Habitat	300.32	38.39	364.80	312.45	167.00	350.36	1533.31

Note:
[1] Acreage values are approximate.

Impact Wild-11 (CP3): Impacts on Special-Status Bats (Pallid Bat, Spotted Bat, Western Red Bat, Western Mastiff Bat, Townsend's Big-Eared Bat, Long-Eared Myotis, Yuma Myotis, and Fringed Myotis), the American Marten, and Ringtail and Their Habitat Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas would result in a loss of habitat for the pallid bat, a California species of special concern, a USFS sensitive species, and a BLM sensitive species; the western red bat, a USFS sensitive species; the western mastiff bat, a California species of special concern, an MSCS-covered species, and a BLM sensitive species; the

Townsend’s big-eared bat, a California species of special concern, a USFS sensitive species, and a BLM sensitive species; the long-eared myotis, a BLM sensitive species; the Yuma myotis, a BLM sensitive species; the fronged myotis, a USFS sensitive species; the American marten, a USFS sensitive species; and the ringtail, a State fully protected and MSCS-covered species. Furthermore, take (including mortality of individuals because of destruction or disturbance of active roost sites or dens) could result from construction activities and vegetation clearing. This impact would be potentially significant.

Impacts caused by construction and vegetation clearing for the dam and relocation areas would be similar to CP1. However, inundation caused by an 18.5-foot raise of Shasta Dam would result in a greater loss of suitable habitat for these species. This impact would be potentially significant.

Dam construction, vegetation removal, and inundation resulting from an 18.5-foot dam raise would result in the loss of approximately 69 acres of reproductive and roosting habitat for the pallid bat, spotted bat, western mastiff bat, Townsend’s big-eared bat, Yuma myotis, and fringed myotis in the impoundment area. Additionally, one limestone cave located on the Big Backbone Arm that is a known Townsend’s big-eared bat roost would be affected by flooding. An 18.5-foot dam raise would result in the loss of approximately 2,431 acres of reproductive and roosting habitat for the western red bat and long-eared myotis. These impacts would be potentially significant.

Dam construction, vegetation removal, and inundation resulting from an 18.5-foot dam raise would result in the loss of approximately 2,431 acres of ringtail habitat. An 18.5-foot dam raise would result in the loss of approximately 1,482 acres of American marten habitat in the impoundment area. These impacts would be potentially significant.

Impacts on suitable habitat by CWHR type in the impoundment area are summarized in Table 13-43.

Mitigation for this impact is proposed in Section 13.3.5.

Table 13-43. Impacts on Suitable Habitat for Special-Status Bats, American Marten, and Ringtail in the Impoundment Area (18.5-Foot Dam Raise)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Pallid Bat, Spotted Bat, Western Mastiff Bat, Townsend's Big-Eared Bat, Yuma Myotis, and Fringed Myotis							
Barren	2.30	1.28[2]	10.60	3.56	0.00	1.35	17.81
Blue oak woodland	0.00	0.00	0.00	0.00	0.00	4.18	4.18
Blue oak–foothill pine	10.36	0.00	0.00	0.00	4.29	32.33	46.98
Total	12.66	0.00	10.60	3.56	4.29	37.86	68.98
Western Red Bat, Long-Eared Myotis, and Ringtail							
Barren	2.30	0.00	10.60	3.56	0.00	1.35	17.81
Blue oak woodland	0.00	0.00	0.00	0.00	0.00	4.18	4.18
Blue oak–foothill pine	10.36	0.00	0.00	0.00	4.29	32.33	46.98
Closed-cone pine-cypress	32.68	0.00	12.95	20.89	44.72	70.52	181.77
Douglas-fir	0.00	0.00	0.00	0.36	0.00	0.00	0.36
Klamath mixed conifer	0.00	0.00	0.00	0.00	0.00	10.96	10.96
Mixed chaparral	29.19	13.64	161.04	15.14	10.35	12.99	242.36
Montane hardwood	73.49	38.76	171.02	70.37	19.43	78.84	451.91
Montane hardwood–conifer	70.68	0.99	150.43	136.54	111.63	179.48	649.76
Montane riparian	4.16	6.67	26.16	13.91	1.53	5.52	57.94
Ponderosa pine	215.11	30.72	188.21	161.64	49.56	122.07	767.30
Total Habitat	437.98	90.78	720.42	422.41	241.51	518.25	2431.35
American Marten							
Douglas-fir	0.00	0.00	0.00	0.36	0.00	0.00	0.36
Klamath mixed conifer	0.00	0.00	0.00	0.00	0.00	6.73	6.73
Montane hardwood–conifer	70.68	0.99	150.43	136.54	111.63	179.48	649.76
Montane riparian	4.16	6.67	26.16	13.91	1.53	5.52	57.94
Ponderosa pine	215.11	30.72	188.21	161.64	49.56	122.07	767.30
Total Habitat	289.95	38.38	364.79	312.45	162.72	313.80	1482.09

Note:
[1] Acreage values are approximate.
[2] Represents the amount of the limestone outcrop impacted at the Big Backbone Arm cave location.

Impact Wild-12 (CP3): Impacts on Special-Status Terrestrial Mollusks (Church's sideband, Shasta Sideband, Wintu Sideband, Oregon shoulderband, Shasta Chaparral, and Shasta Hesperian) and Their Habitat All of these species are designated USFS sensitive and/or S&M species, and the Shasta sideband is also an MSCS-covered species. The Shasta Sideband, Wintu Sideband, Shasta Chaparral, and Shasta Hesperian are also petitioned for Federal listing. Ground-disturbing activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas could result in direct take and/or loss of suitable habitat for special-status terrestrial mollusks. In addition, the raising of Shasta Dam would result in the inundation of suitable habitat and direct take of these species. This impact would be significant.

Impacts caused by construction and vegetation clearing for the dam and relocation areas would be similar to CP1. However, inundation caused by an 18.5-foot raise of Shasta Dam would result in a greater loss of suitable habitat for these species. This impact would be potentially significant.

Inundation resulting from an 18.5-foot dam raise would result in the loss of approximately 2,415 acres of Church's sideband, Oregon shoulderband, and Shasta chaparral habitat; and 58 acres of Shasta hesperian habitat in the impoundment area. Approximately 11 acres of Shasta sideband habitat and 3 acres of Wintu sideband habitat would be lost. These impacts would be potentially significant.

Impacts on suitable habitat by CWHR type in the impoundment area are summarized in Table 13-44.

Mitigation for this impact is proposed in Section 13.3.5.

Table 13-44. Impacts on Suitable Habitat for Special-Status Terrestrial Mollusks in the Impoundment Area (18.5-Foot Dam Raise)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Impoundment Area: Shasta Sideband							
Limestone	0.00	0.00	0.00	11.09	0.00	0.00	11.09
Impoundment Area: Wintu Sideband							
Limestone	0.00	0.00	0.00	0.00	0.00	2.85	2.85
Impoundment Area: Church's sideband, Oregon shoulderband, Shasta Chaparral							
Barren	1.06	0.00	0.55	0.00	0.00	0.00	1.61
Blue oak woodland	0.00	0.00	0.00	0.00	0.00	4.18	4.18
Blue oak–foothill pine	10.36	0.00	0.00	0.00	4.29	32.33	46.98
Closed-cone pine-cypress	32.68	0.00	12.95	20.89	44.72	70.52	181.77
Douglas-fir	0.00	0.00	0.00	0.36	0.00	0.00	0.36
Klamath mixed conifer	0.00	0.00	0.00	0.00	0.00	10.96	10.96
Mixed chaparral	29.19	13.64	161.04	15.14	10.35	12.99	242.36
Montane hardwood	73.49	38.76	171.02	70.37	19.43	78.84	451.91
Montane hardwood–conifer	70.68	0.99	150.43	136.54	111.63	179.48	649.76

Table 13-44. Impacts on Suitable Habitat for Special-Status Terrestrial Mollusks in the Impoundment Area (18.5-Foot Dam Raise) (contd.)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Montane riparian	4.16	6.67	26.16	13.91	1.53	5.52	57.94
Ponderosa pine	215.11	30.72	188.21	161.64	49.56	122.07	767.30
Total Habitat	436.74	90.78	710.36	418.85	241.51	516.90	2415.14
Impoundment Area: Shasta Hesperian							
Montane riparian	4.16	6.67	26.16	13.91	1.53	5.52	57.94
Total Habitat	4.16	6.67	26.16	13.91	1.53	5.52	57.94

Note:
[1] Acres are approximate.

Impact Wild-13 (CP3): Permanent Loss of General Wildlife Habitat and Western Bumble Bee Habitat Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas would result in a permanent loss of habitat. In addition, inundation caused by the raising of Shasta Dam would result in the permanent loss of habitat. This would be a potentially significant impact.

These general habitats also represent potential western bumble bee habitat. Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas would result in a permanent loss of habitat containing flowering shrubs and forbs, which serve as potential western bumble bee nectar sources, and potential underground burrow locations. In addition, inundation caused by the raising of Shasta Dam would result in the permanent loss of habitat. This would be a potentially significant impact.

Impacts caused by construction and vegetation clearing for the dam and relocation areas would be similar to CP2. However, inundation caused by an 18.5-foot raise of Shasta Dam would result in a greater loss of general wildlife habitat and western bumble bee habitat. This impact would be potentially significant.

Inundation resulting from an 18.5-foot dam raise would result in a loss of approximately 2,492 acres of general wildlife habitat and western bumble bee habitat in the impoundment area. Impacts on general wildlife habitat and western bumble bee habitat by CWHR type in the impoundment area are summarized in Table 13-45.

Mitigation for this impact is proposed in Section 13.3.5.

Table 13-45. Impacts on CWHR Habitats and Western Bumble Bee Habitat in the Impoundment Area (18.5-Foot Dam Raise)

Habitat	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Annual grassland	0.44	0.00	3.10	0.70	0.00	0.38	4.62
Barren	2.30	0.00	10.60	3.56	0.00	1.35	17.81
Blue oak–foothill pine	10.36	0.00	0.00	0.00	4.29	4.18	4.18
Blue oak woodland	0.00	0.00	0.00	0.00	0.00	32.33	46.98
Closed-cone pine–cypress	32.68	0.00	12.95	20.89	44.72	70.52	181.77
Douglas-fir	0.00	0.00	0.00	0.36	0.00	0.00	0.36
Mixed chaparral	29.19	13.64	161.04	15.14	10.35	13.00	242.36
Montane hardwood	73.49	38.76	171.01	70.55	19.43	78.84	451.91
Montane hardwood–conifer	70.68	0.99	150.42	136.36	111.63	179.48	649.76
Montane riparian	4.16	6.67	26.16	13.91	1.53	5.52	57.94
Ponderosa pine	215.11	30.72	188.19	161.64	49.56	122.07	767.30
Riverine	0.00	0.88	5.24	15.43	1.41	0.00	22.96
Urban	21.95	0.00	1.95	7.96	0.00	1.27	33.14
Total	460.37	91.67	730.72	446.49	242.92	519.90	2492.07

Note:
[1] Acreage values are approximate.

Impact Wild-14 (CP3): Impacts on Other Birds of Prey (e.g., red-tailed hawk and red-shouldered hawk) and Migratory Bird Species (e.g., American robin, Anna's hummingbird) and their Foraging and Nesting Habitat Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas during the nesting season could result in the incidental loss of fertile eggs or nestlings or otherwise lead to the abandonment of nests of other birds of prey and migratory bird species. In addition, inundation caused by the raising of Shasta Dam could result in the loss of active nests and habitat for these species. This impact would be potentially significant.

Impacts caused by construction and vegetation clearing for the dam and relocation areas would be similar to CP1. However, inundation caused by an 18.5-foot raise of Shasta Dam would result in greater impacts on nesting migratory birds and raptors. This impact would be potentially significant.

Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-15 (CP3): Loss of Critical Deer Winter and Fawning Range Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas would result in a loss of critical deer winter and fawning range. In addition, inundation caused by the raising of

Shasta Dam would result in the loss of critical deer range. This would be a potentially significant impact.

Impacts caused by construction and vegetation clearing for the dam and relocation areas would be similar to CP1. However, inundation caused by an 18.5-foot raise of Shasta Dam would result in the loss of approximately 5,182 acres of critical deer winter and/or fawning range. This impact would be potentially significant.

Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-16 (CP3): Take and Loss of the California Red-Legged Frog Reclamation completed California red-legged frog habitat assessments in coordination with the USFWS in the applicable impoundment and relocation areas, and the potential downstream Sacramento River restoration sites. The assessment results will enable Reclamation and the USFWS to determine if habitat for the species occurs, if impacts are anticipated, and if additional surveys are needed. Impacts on the California red-legged frog will be assessed if surveys are conducted and the California red-legged frog is found. Impacts for each alternative will not be assessed until USFWS has determined whether suitable habitat is present and whether surveys would be required. Mitigation for this impact is discussed in Section 13.3.5.

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact Wild-17 (CP3): Impacts on Riparian-Associated Special-Status Wildlife Resulting from Modifications to the Existing Flow Regime in the Primary Study Area Implementing CP3 would increase available water storage in Shasta Reservoir and result in a modified flow regime. This modification would reduce the frequency, duration, and magnitude of intermediate to large flows downstream from Shasta Dam during winter and spring in some water years, and would increase the volume of flows from spring through fall of some water year types. This change in surface and subsurface hydrology could affect habitats adjacent to the river channel and reduce the formation of off-channel habitats, which would adversely affect the habitat of western pond turtle. Although the total amount of riparian vegetation would not decline substantially, the portion in early successional stages would be reduced. These early successional stages provide habitat for some special-status wildlife species. These changes could result in substantial effects on the distribution or abundance of riparian-nesting special-status bird species. Because CP3 would substantially alter habitat for a variety of riparian-dependent special-status species, this impact would be potentially significant.

This impact would be similar to Impact Wild-17 (CP1). The goal of CP3 is to increase agricultural water supply reliability, as is evident in the CalSim-II modeling results. As modeled, in dry and critical water years, flows are generally higher – substantially so in several months – for the entire growing season, extending into November (Table 13-46). This additional water is available during the growing season because of the increase in reservoir storage. Similar to results for CP1 and CP2, flows are shown to be substantially lower in winter and early spring as the larger reservoir captures more runoff. As discussed in Impact Wild-17 (CP1), the increased storage capacity reduces the frequency of channel-forming flows that create habitat for sensitive species like western pond turtle. This reduction in flows would also lead to a long-term reduction in early successional stage riparian habitat used by many species of riparian-dependent sensitive species of birds. The change in flow regimes would substantially reduce habitat for sensitive species of riparian-dependent wildlife. For this reason, this impact would be potentially significant. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-18 (CP3): Impacts on Bank Swallow in the Primary Study Area Resulting from Modifications of Geomorphic Processes Implementing CP3 would cause a reduction in the magnitude, duration, and frequency of intermediate to large flows in the Sacramento River in the primary study area. This reduction also would alter the river's geomorphic processes, including the rate of bank erosion. However, the length of eroding banks would not be substantially altered, and thus, nesting habitat for bank swallows would not decline substantially. High flows during the nesting season that may cause localized nest failure would not increase. The impact on habitat for bank swallow nesting colonies would be less than significant.

This impact would be similar to Impact Wild-18 (CP1). Generally installed to protect upland land uses, bank revetment has been preferentially applied to actively eroding and migrating bends that otherwise would be among the most suitable sites for bank swallow nests. The reduction in intermediate to large flows by CP3 would cause a small reduction in the rate of erosion at the cut banks that remain unprotected by revetment. This alteration would not reduce the amount of bank swallow nesting habitat in the short or long term. The increase in water surface elevation is modeled to average about 2 inches or less during the breeding season (April–July) in all water year types. Although the flow increase exceeds the ±2 percent threshold that is used to discriminate between conditions essentially equivalent to existing conditions, the actual increase in elevation is not likely to result in additional flooding of bank swallow colonies. Because CP3 would not result in a substantial reduction in available habitat or in nesting colonies, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Table 13-46. Percent Change in Average Monthly Flows at Keswick Dam and Downstream Under CP3

Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Keswick												
Wet	1.0%	2.7%	-10.2%	-6.2%	-1.4%	0.3%	0.3%	0.6%	0.7%	0.7%	0.8%	2.7%
Above Normal	5.9%	1.1%	-4.3%	-3.5%	-6.8%	-8.0%	0.8%	-2.2%	-3.0%	0.4%	1.2%	10.4%
Below Normal	1.7%	-0.2%	-1.8%	-1.5%	0.5%	-2.1%	2.0%	-1.8%	1.2%	1.2%	1.9%	3.0%
Dry	6.6%	7.0%	-2.6%	-3.3%	-1.2%	-0.1%	2.6%	4.3%	3.4%	2.2%	6.3%	3.5%
Critical	1.1%	7.2%	2.8%	-1.8%	1.0%	0.3%	1.9%	2.0%	1.0%	0.8%	2.0%	6.2%
Bend Bridge												
Wet	0.9%	2.7%	-5.4%	-2.7%	-0.8%	0.2%	0.2%	0.5%	0.6%	0.7%	0.7%	2.4%
Above Normal	4.7%	0.1%	-2.0%	-2.0%	-3.8%	-4.5%	0.6%	-1.4%	-2.2%	0.3%	1.0%	9.9%
Below Normal	1.5%	0.3%	-1.2%	-0.8%	0.4%	-1.5%	1.4%	-0.9%	1.2%	1.1%	1.7%	2.6%
Dry	5.3%	6.1%	-1.4%	-1.6%	-0.6%	0.0%	2.0%	3.4%	3.1%	2.1%	6.1%	3.0%
Critical	0.7%	5.9%	2.4%	-1.4%	0.9%	0.2%	1.5%	1.7%	0.9%	0.8%	2.0%	5.6%
Butte City												
Wet	1.1%	3.4%	-4.1%	-1.6%	-0.6%	0.2%	0.3%	0.1%	0.2%	0.3%	0.5%	2.3%
Above Normal	5.1%	0.3%	-1.7%	-1.3%	-2.9%	-3.0%	0.8%	-2.1%	-2.9%	-0.4%	0.6%	10.7%
Below Normal	1.9%	0.6%	-0.9%	-1.0%	0.5%	-1.4%	1.5%	-0.9%	1.0%	0.7%	1.3%	2.1%
Dry	5.8%	6.7%	-1.0%	-1.0%	-0.2%	-0.1%	2.6%	3.1%	3.4%	1.6%	7.6%	2.4%
Critical	0.7%	6.5%	2.7%	-1.3%	1.0%	0.1%	1.9%	2.1%	1.0%	0.7%	2.3%	5.6%
Wilkins Slough												
Wet	1.1%	3.6%	-2.3%	-0.8%	-0.1%	0.3%	0.3%	0.1%	0.2%	0.3%	0.5%	2.3%
Above Normal	5.1%	0.3%	-1.4%	-0.8%	-1.4%	-1.5%	0.8%	-2.1%	-2.9%	-0.4%	0.6%	10.7%
Below Normal	1.9%	0.6%	-0.2%	-1.0%	0.7%	-1.4%	1.5%	-0.9%	1.0%	0.7%	1.3%	2.1%
Dry	5.8%	6.7%	-1.0%	-0.9%	-0.2%	-0.1%	2.6%	3.1%	3.4%	1.6%	7.6%	2.4%
Critical	0.7%	6.5%	2.7%	-1.3%	1.0%	0.1%	1.9%	2.1%	1.0%	0.7%	2.3%	5.6%
Verona												
Wet	0.9%	2.7%	-2.3%	-0.6%	-0.1%	0.1%	0.1%	-0.1%	0.2%	0.1%	-0.1%	0.9%
Above Normal	3.6%	1.3%	-1.1%	-0.5%	-1.9%	-1.0%	0.5%	-0.7%	-1.7%	-0.1%	0.4%	4.4%
Below Normal	1.7%	0.4%	0.9%	-0.3%	0.3%	-1.4%	0.9%	0.0%	1.2%	0.5%	0.5%	0.5%
Dry	3.7%	4.7%	-0.9%	-0.4%	-0.3%	-0.1%	1.7%	2.0%	2.8%	1.6%	2.3%	2.6%
Critical	0.1%	4.8%	2.1%	-0.8%	0.8%	0.0%	1.2%	0.3%	0.9%	2.4%	2.3%	3.9%

Table 13-46. Percent Change in Average Monthly Flows at Keswick Dam and Downstream Under CP3 (contd.)

Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Freeport												
Wet	0.5%	1.1%	-0.5%	-0.5%	0.1%	0.1%	0.1%	-0.1%	0.1%	0.0%	-0.1%	0.3%
Above Normal	1.9%	-0.6%	-0.4%	0.2%	-0.5%	-0.8%	0.4%	-0.5%	-1.4%	-0.2%	0.1%	0.8%
Below Normal	0.4%	-0.2%	1.5%	0.5%	0.4%	-1.2%	0.9%	-0.5%	0.1%	0.1%	0.2%	0.6%
Dry	2.2%	3.4%	-0.6%	-0.3%	0.1%	0.1%	1.5%	1.5%	-0.3%	0.7%	2.6%	2.0%
Critical	0.0%	3.1%	2.0%	-0.6%	0.9%	0.4%	0.9%	0.0%	-0.1%	1.7%	1.6%	1.5%

Impact Wild-19 (CP3): Disturbance or Removal of Vernal Pool Habitat for Special-Status Wildlife from Changes in Flow Regime As mentioned in Impact Wild-19 (CP1), vernal pools are generally not present within the active floodplain of the upper Sacramento River in the primary study area; vernal pools are found in upland locations outside of the main river channel and the floodplain. Thus, vernal pools are not anticipated to be affected by changes in flows that could result from implementation of CP3. Because CP3 would not affect vernal pool habitat or the species that occur within the habitat, no impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact Wild-20 (CP3): Consistency with Local and Regional Plans with Goals of Promoting Riparian Habitat in the Primary Study Area Several conservation and management plans have been adopted in the primary and extended study areas with goals of promoting riparian habitat along the Sacramento River. Because flow regimes and riverine geomorphic processes could be altered with project implementation, riparian habitat could be affected in such a manner that the goals of the local and regional plans would be more difficult to attain. Therefore, this impact would be potentially significant.

This impact would be similar to Impact Wild-20 (CP1). The alteration of flows resulting from CP3 would continue to adversely affect riparian habitat. This would make the achievement of restoration, preservation, and conservation goals under regional and local plans and policies more difficult to attain. Therefore, this impact would be potentially significant. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-21 (CP3): Impacts on Riparian-Associated Special-Status Wildlife Resulting from the Gravel Augmentation Program Gravel augmentation is not included as part of CP3. Therefore, no impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact Wild-22 (CP3): Impacts on Riparian-Associated Special-Status Wildlife Species Resulting from Restoration Projects CP3 would not include any specific restoration components. Therefore, no impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta

Impact Wild-23 (CP3): Impacts on Riparian-Associated and Aquatic Special-Status Wildlife Resulting from Modifications to Existing Flow Regimes in the Lower Sacramento River and Delta Implementing CP3 would modify the flow regime and would reduce the frequency, duration, and magnitude of intermediate to large flows in the lower Sacramento River during winter and spring in some years, but generally not above the ±2 percent threshold that separates the alternative from existing conditions. Under CP3 there would be increases in lower Sacramento River flows during the growing season, especially in the drier water years, that would occur as water was delivered to agricultural diversions. Many of these increases would exceed the ±2 percent threshold and therefore are considered substantial flow changes. Although this change in surface and subsurface hydrology would be of a smaller magnitude than in the upper Sacramento River, it could affect habitats adjacent to the river channel and the formation of off-channel habitats, which would adversely affect the habitat of western pond turtle. Although the total amount of riparian vegetation would not decline substantially, the portion in early successional stages would be reduced. These early successional stages provide habitat for some special-status wildlife species. These changes could result in substantial effects on the distribution and abundance of riparian-nesting special-status bird species. Because CP3 would substantially alter habitat for a variety of riparian-dependent special-status species, this impact would be potentially significant.

This impact would be similar to Impact Wild-23 (CP1). Implementing CP3 would modify the flow regime and would reduce the frequency, duration, and magnitude of intermediate to large flows in the lower Sacramento River during winter and spring in some years, but generally not above the ±2 percent threshold that separates the alternative from existing conditions (except at Verona in December of wet water years). Because the focus of CP3 is the delivery of water for agricultural uses, under CP3 there would be increases in lower Sacramento River flows during the growing season, especially in the drier water years, that would occur as water was delivered to agricultural diversions. As modeled, many of these increases in lower Sacramento River flows exceed the ±2 percent threshold (Table 13-46) and therefore are considered substantial flow changes. Because CP3 could substantially reduce available habitat for special-status wildlife, this impact would be potentially significant. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-24 (CP3): Impacts on Bank Swallow along the Lower Sacramento River Resulting from Modifications of Geomorphic Processes Implementing CP3 would cause a small reduction in the magnitude, duration, and frequency of intermediate to large flows in the lower Sacramento River. This reduction also would alter the river's geomorphic processes. The rate of bank erosion could be different than the existing rate, but the length of eroding banks would not be substantially altered, and thus, nesting habitat for bank swallows would not be decline substantially. High flows during the nesting season that may cause localized bank and nest failure would not increase substantially. The impact on habitat for bank swallow nesting colonies, and therefore bank swallows themselves, would be less than significant.

This impact would be similar to Impact Wild-24 (CP1). The factors affecting bank erosion have been discussed previously. The effect of CP3 on bank swallow habitat along the lower Sacramento River would be similar to the effect along the upper Sacramento River, but smaller because the effect of CP3 on river flows would attenuate somewhat with distance downstream. The different operational goals of CP3 would actually increase average flows in the lower Sacramento River during November and December. Modeling shows only minor reductions in flows (less than 2 percent) during January and February.

The changes in flows predicted by CalSim-II are not expected to substantially alter the rate or extent of bank erosion. The maximum increase in average monthly water surface elevation predicted for the lower Sacramento River is generally less than 3 inches; this is not expected to result in a substantial increase in flooding of bank swallow nesting colonies. Because CP3 would not result in substantial changes in available habitat, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Wild-25 (CP3): Disturbance or Removal of Vernal Pool Habitat for Special-Status Wildlife Along the Lower Sacramento River and in the Delta from Changes in Flow Regime of the Sacramento River and Affected Tributaries, and Changes in Seasonal Water Availability Vernal pools are present in upland areas near the Sacramento River and its tributaries in the extended study area. These pools provide habitat for numerous special-status species. Critical habitat for three special-status species (vernal pool fairy shrimp, vernal pool tadpole shrimp, and Conservancy fairy shrimp) is located within the extended study area. Critical habitat for these species is confined to vernal pool communities (USFWS 2006). However, vernal pools are generally not present within the active floodplain of regulated rivers along the lower Sacramento River and in the Delta. Because the sensitive habitat and species are located outside of the area affected by the changes in flows, CP3 would not alter this habitat. Therefore, no impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact Wild-26 (CP3): Consistency with Local and Regional Plans with Goals of Promoting Riparian Habitat Along the Lower Sacramento River and in the Delta Several conservation and management plans have been adopted in the primary and extended study areas with goals of promoting riparian habitat along the Sacramento River. Because flow regimes and riverine geomorphic processes could be altered with project implementation, riparian habitat could be affected in such a manner that the goals of the local and regional plans would be more difficult to attain. Therefore, this impact would be potentially significant.

This impact would be similar to Impact Wild-26 (CP1) and would be potentially significant. Mitigation for this impact is proposed in Section 13.3.5.

CVP/SWP Service Areas

Impact Wild-27 (CP3): Impacts on Riparian-Associated or Aquatic Special-Status Wildlife in the CVP/SWP Service Areas Resulting from Modifications to Existing Flow Regimes By altering storage and operations at several reservoirs associated with the CVP and SWP service areas, CP3 would change flow regimes in several downstream waterways. Most potential noticeable changes in flows and stages would diminish downstream from Red Bluff. The change in surface and subsurface hydrology could affect habitats adjacent to the river channel that provide habitat for special-status wildlife species. These changes are unlikely to result in substantial effects on the distribution or abundance of riparian-associated or aquatic special-status wildlife species in the CVP and

SWP service areas outside of the primary study area. Therefore, this impact would be less than significant.

This impact would be similar to Impact Wild-27 (CP1). Modified flow regimes would change the frequency, duration, and magnitude of intermediate to large flows along the Sacramento River. However, based on the CalSim-II modeling results, the hydrologic effects in tributaries with CVP and SWP dams, outside of the primary study area, are expected to be less than effects on the Sacramento River. The CVP and SWP are operated as an integrated system with the same downstream management targets and goals. CVP and SWP operations are constrained by the 2008 USFWS BO and the 2009 NMFS BO. Thus, this alternative is not anticipated to sufficiently alter flow to the CVP/SWP service areas to have a substantial effect on the riparian habitat upon which special-status wildlife species depend. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

CP4 and CP4A – 18.5-Foot Dam Raise, Anadromous Fish Focus with Water Supply Reliability

The primary function of CP4 and CP4A is to address survival of anadromous fish, while still improving water supply reliability. CP4 and CP4A focus on increasing the volume of cold water available to the temperature control device through reservoir reoperations and on raising Shasta Dam by 18.5 feet. As with CP3 and the common features above, this raise would increase the full pool by 20.5 feet and enlarge total reservoir storage space by 634,000 acre-feet.

CP4 and CP4A have similar reservoir operations in that they each dedicate a portion of the new storage in Shasta Lake for fisheries purposes, however, the portion of this dedicated storage varies. For CP4, about 378,000 acre-feet of the increased reservoir storage space would be dedicated to increasing the supply of cold water for anadromous fish survival purposes. Operations for the remaining portion of increased storage (approximately 256,000 acre-feet) would be the same as in CP1. For CP4A, about 191,000 acre-feet of the increased reservoir storage space would be dedicated to increasing the supply of cold water for anadromous fish survival purposes. For CP4A, operations for the remaining portion of increased storage (approximately 443,000 acre-feet) would be the same as in CP2.

In addition to the activities common to CP1–CP3, CP4 and CP4A include augmenting locations along the Upper Sacramento River segment of the study area with gravel to increase spawning habitat for anadromous fish. Gravel placement would occur at one or more sites per year over a 10-year period and would be accomplished by one of three methods; lateral berms, talus cone, direct placement in river; as appropriate depending on specific conditions, including geomorphology, of the augmentation site. To the extent available, existing river access points would be used to deliver gravel to the river; however, temporary new access roads would be needed in some cases, mostly adjacent to the river, and would be extended from existing dirt roads.

Furthermore, under CP4 and CP4A, riparian, floodplain, and side channel habitat restoration would be implemented at up to six potential sites on the upper Sacramento River to restore habitat for anadromous salmonids.

With respect to wildlife impacts, dam construction activities for CP1–CP5 would be so similar that they are considered to be identical for purposes of this analysis. Because CP4 or CP4A would result in lake levels identical to those under CP3, CP4 or CP4A would require the same relocation of utilities, public service facilities, and recreational facilities as CP3, including a loss of up to 35 acres of limestone habitat and 2,870 acres of nonlimestone habitat. Because CP4 or CP4A would result in identical lake levels as CP3, CP4 or CP4A would result the same area of inundation as CP3, in turn requiring identical vegetation clearing within the inundation area as CP3. CP4 or CP4A would also involve some vegetation clearing in the Upper Sacramento River portion of the study area to provide access for gravel augmentation.

Shasta Lake and Vicinity

Impact Wild-1 (CP4 and CP4A): Take and Loss of Habitat for the Shasta Salamander Ground-disturbing activities associated with construction could result in direct take of the Shasta salamander, a State-listed species, USFS sensitive species, S&M species, MSCS-covered species, and BLM sensitive species. In addition, the raising of Shasta Dam would result in the inundation of habitat for this species. This impact would be significant for CP4 or CP4A.

This impact would be similar to Impact Wild-1 (CP3) and would be significant for CP4. Mitigation for this impact is proposed in Section 13.3.5.

This impact would be similar to Impact Wild-1 (CP3) and would be significant for CP4A. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-2 (CP4 and CP4A): Impact on the Foothill Yellow-Legged Frog and Tailed Frog and Their Habitat Ground-disturbing activities associated with construction could result in direct take (e.g., because of operation of equipment in or adjacent to riverine or riparian habitat) of the foothill yellow-legged frog, a California species of special concern, a USFS sensitive species, an MSCS-covered species, and a BLM sensitive species, and of the tailed frog, a California species of special concern. In addition, the raising of Shasta Dam would result in the conversion of suitable riverine and riparian habitat to unsuitable lacustrine habitat. This impact would be potentially significant for CP4 or CP4A.

This impact would be similar to Impact Wild-2 (CP3) and would be potentially significant for CP4. Mitigation for this impact is proposed in Section 13.3.5.

This impact would be similar to Impact Wild-2 (CP3) and would be potentially significant for CP4A. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-3 (CP4 and CP4A): Impact on the Northwestern Pond Turtle and Its Habitat Ground-disturbing activities associated with construction could result in direct take (e.g., because of operation of equipment in or adjacent to riverine or riparian habitat) of the northwestern pond turtle, an MSCS-covered species, a California species of special concern, and a USFS sensitive species. In addition, project implementation could result in the degradation of suitable aquatic habitat because of increased erosion and sedimentation. This impact would be potentially significant.

This impact would be similar to Impact Wild-3 (CP3) and would be potentially significant for CP4. Mitigation for this impact is proposed in Section 13.3.5.

This impact would be similar to Impact Wild-3 (CP3) and would be potentially significant for CP4A. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-4 (CP4 and CP4A): Impact on the American Peregrine Falcon Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas during the nesting season could result in the incidental loss of fertile eggs or nestlings or otherwise lead to the abandonment of nests of American peregrine falcons, a State fully protected species and MSCS-covered species. This impact would be potentially significant for CP4 or CP4A.

This impact would be similar to Impact Wild-4 (CP3) and would be potentially significant for CP4. Mitigation for this impact is proposed in Section 13.3.5.

This impact would be similar to Impact Wild-4 (CP3) and would be potentially significant for CP4A. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-5 (CP4 and CP4A): Take and Loss of Habitat for the Bald Eagle Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas in addition to inundation caused by the raising of Shasta Dam during the nesting season would result in the loss of nest and perch trees used by the bald eagle, a State-listed species, fully protected species, and USFS sensitive species, an MSCS-covered species, and a BLM sensitive species. This impact would be significant.

This impact would be similar to Impact Wild-5 (CP3) and would be potentially significant for CP4. Mitigation for this impact is proposed in Section 13.3.5.

This impact would be similar to Impact Wild-5 (CP3) and would be potentially significant for CP4A. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-6 (CP4 and CP4A): Loss of Dispersal Habitat for the Northern Spotted Owl Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas would result in the loss of northern spotted owl dispersal habitat, a species Federally listed as threatened and an MSCS-covered species. This impact would be potentially significant.

This impact would be similar to Impact Wild-6 (CP3) and would be potentially significant for CP4. Mitigation for this impact is proposed in Section 13.3.5.

This impact would be similar to Impact Wild-6 (CP3) and would be potentially significant for CP4A. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-7 (CP4 and CP4A): Impact on the Purple Martin and Its Nesting Habitat Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas during the nesting season could result in the incidental loss of fertile eggs or nestlings or otherwise lead to the abandonment of nests of purple martins, a California species of special concern. In addition, inundation caused by the raising of Shasta Dam would result in the loss of nest trees. This impact would be significant for CP4 or CP4A.

This impact would be similar to Impact Wild-7 (CP3) and would be significant for CP4. Mitigation for this impact is proposed in Section 13.3.5.

This impact would be similar to Impact Wild-7 (CP3) and would be significant for CP4A. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-8 (CP4 and CP4A): Impacts on the Willow Flycatcher, Vaux's Swift, Yellow Warbler, and Yellow-Breasted Chat and Their Foraging and Nesting Habitat Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas during the nesting season could result in the incidental loss of fertile eggs or nestlings or otherwise lead to the abandonment of nests of the willow flycatcher, a species State listed as endangered, a USFS sensitive species, and MSCS-covered species; the Vaux's swift, a California species of special concern; and the yellow warbler and yellow-breasted chat, both California species of special concern and MSCS-covered species. In addition, the raising of Shasta Dam would result in the loss of habitat, including nesting habitat, for these species. This impact would be potentially significant for CP4 or CP4A.

This impact would be similar to Impact Wild-8 (CP3) and would be potentially significant for CP4. Mitigation for this impact is proposed in Section 13.3.5.

This impact would be similar to Impact Wild-8 (CP3) and would be potentially significant for CP4A. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-9 (CP4 and CP4A): Impacts on the Long-Eared Owl, Northern Goshawk, Cooper's Hawk, Great Blue Heron, and Osprey and Their Foraging *and Nesting Habitat* Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas during the nesting season could result in the incidental loss of fertile eggs or nestlings or otherwise lead to the abandonment of nests of the long-eared owl, a California species of special concern and an MSCS-covered species; the northern goshawk, a California species of special concern, a USFS sensitive species, and a BLM sensitive species; the Cooper's hawk, an MSCS-covered species; the great blue heron, an MSCS-covered species; and the osprey, an MSCS-covered species. In addition, the raising of Shasta Dam would result in the loss of foraging and nesting habitat for these species. This impact would be potentially significant for CP4 and CP4A.

This impact would be similar to Impact Wild-9 (CP3) and would be potentially significant for CP4. Mitigation for this impact is proposed in Section 13.3.5.

This impact would be similar to Impact Wild-9 (CP3) and would be potentially significant for CP4A. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-10 (CP4 and CP4A): Take and Loss of Habitat for the Pacific Fisher Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas would result in a loss of habitat for the Pacific fisher, a Federal candidate for listing, a California species of special concern, a USFS sensitive species, and a BLM sensitive species. Furthermore, take (including mortality of individuals because of destruction or disturbance of active roost sites or dens) could result from construction activities and vegetation clearing. This impact would be potentially significant for CP4 or CP4A.

This impact would be similar to Impact Wild-10 (CP3) and would be potentially significant for CP4. Mitigation for this impact is proposed in Section 13.3.5.

This impact would be similar to Impact Wild-10 (CP3) and would be potentially significant for CP4A. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-11 (CP4 and CP4A): Impacts on Special-Status Bats (Pallid Bat, Spotted Bat, Western Red Bat, Western Mastiff Bat, Townsend's Big-Eared Bat, Long-Eared Myotis, Yuma Myotis, and Fringed Myotis), the American Marten, and Ringtail and Their Habitat Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas would result in a loss of habitat for the pallid bat, a California species of special concern, a USFS sensitive species, and a BLM sensitive species; the western red bat, a USFS sensitive species; the western mastiff bat, a California species of special concern, an MSCS-covered species, and a BLM sensitive species; the Townsend's big-eared bat, a California species of special concern, a USFS sensitive species, and a BLM sensitive species; the long-eared myotis, a BLM sensitive species; the Yuma myotis, a BLM sensitive species; the fringed myotis, a USFS sensitive species; the American marten, a USFS sensitive species; and the ringtail, a State fully protected and MSCS-covered species. Furthermore, take (including mortality of individuals because of destruction or disturbance of active roost sites or dens) could result from construction activities and vegetation clearing. This impact would be potentially significant for CP4 and CP4A.

This impact would be similar to Impact Wild-11 (CP3) and would be potentially significant for CP4. Mitigation for this impact is proposed in Section 13.3.5.

This impact would be similar to Impact Wild-11 (CP3) and would be potentially significant for CP4A. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-12 (CP4 and CP4A): Impacts on Special-Status Terrestrial Mollusks (Church's sideband, Shasta Sideband, Wintu Sideband, Oregon shoulderband, Shasta Chaparral, and Shasta Hesperian) and Their Habitat
All of these species are designated USFS sensitive and/or S&M species, and the Shasta sideband is also an MSCS-covered species. The Shasta Sideband, Wintu Sideband, Shasta Chaparral, and Shasta Hesperian are also petitioned for Federal listing. Ground-disturbing activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas could result in direct take and/or loss of suitable habitat for special-status terrestrial mollusks. In addition, the raising of Shasta Dam would result in the inundation of suitable habitat and direct take of these species. This would be a significant impact for CP4 or CP4A.

This impact would be similar to Impact Wild-12 (CP3) and would be significant for CP4. Mitigation for this impact is proposed in Section 13.3.5.

This impact would be similar to Impact Wild-12 (CP3) and would be significant for CP4A. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-13 (CP4 and CP4A): Permanent Loss of General Wildlife Habitat and Western Bumble Bee Habitat Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas would result in a permanent loss of habitat. In addition, inundation caused by the raising of Shasta Dam would result in a permanent loss of habitat. This would be a potentially significant impact for CP4 or CP4A.

This impact would be similar to Impact Wild-13 (CP3) and would be potentially significant for CP4. Mitigation for this impact is proposed in Section 13.3.5.

This impact would be similar to Impact Wild-13 (CP3) and would be potentially significant for CP4A. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-14 (CP4 and CP4A): Impacts on Other Birds of Prey (e.g., red-tailed hawk and red-shouldered hawk) and Migratory Bird Species (e.g., American robin, Anna's hummingbird) and their Foraging and Nesting Habitat Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas during the nesting season could result in the incidental loss of fertile eggs or nestlings or otherwise lead to the abandonment of nests of other birds of prey and migratory bird species. In addition, inundation caused by the raising of Shasta Dam could result in the loss of active nests and habitat for these species. This impact would be potentially significant for CP4 or CP4A.

This impact would be similar to Impact Wild-14 (CP3) and would be potentially significant for CP4. Mitigation for this impact is proposed in Section 13.3.5.

This impact would be similar to Impact Wild-14 (CP3) and would be potentially significant for CP4A. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-15 (CP4 and CP4A): Loss of Critical Deer Winter and Fawning Range Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas would result in a loss of critical deer winter and fawning range. In addition, inundation caused by the raising of Shasta Dam would result in the loss of critical deer range. This would be a potentially significant impact for CP4 or CP4A.

This impact would be identical to Impact Wild-15 (CP3) and would be potentially significant for CP4. Mitigation for this impact is proposed in Section 13.3.5.

This impact would be identical to Impact Wild-15 (CP3) and would be potentially significant for CP4A. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-16 (CP4 and CP4A): Take and Loss of the California Red-Legged Frog Reclamation completed California red-legged frog habitat assessments in coordination with the USFWS in the applicable impoundment and relocations areas, and the potential downstream Sacramento River restoration sites. The assessment results will enable Reclamation and the USFWS to determine if habitat for the species occurs, if impacts are anticipated, and if additional surveys are needed. Impacts on the California red-legged frog will be assessed if surveys are conducted and the California red-legged frog is found. Impacts for each alternative will not be assessed until USFWS has determined whether suitable habitat is present and whether surveys would be required. Mitigation for this impact is discussed in Section 13.3.5.

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact Wild-17 (CP4 and CP4A): Impacts on Riparian-Associated Special-Status Wildlife Resulting from Modifications to the Existing Flow Regime in the Primary Study Area Implementation of CP4 or CP4A would increase the available water storage in Shasta Reservoir and result in a modified flow regime. This modification would reduce the frequency, duration, and magnitude of intermediate to large flows downstream from Shasta Dam during winter and spring in some years, especially wet and above-normal water years. Conversely, CP4 or CP4A would increase flow volumes in summer and fall of most years, most dramatically in September and October, because more water would be available to enhance conditions for anadromous fish (the goal of both CP4 and CP4A) in the driest months. This change in surface and subsurface hydrology could affect habitats adjacent to the river channel and reduce the formation of off-channel habitats, which would adversely affect the habitat of western pond turtle. Although the total amount of riparian vegetation would not decline substantially, the portion in early successional stages would be reduced. These early successional stages provide habitat for some special-status wildlife species. These changes could result in substantial effects on the distribution or abundance of riparian-nesting special-status bird species. Because CP4 or CP4A would substantially alter habitat for a variety of riparian-dependent special-status species, this impact would be potentially significant.

The operational rules that govern the management of reservoirs and delivery of water under CP4 are identical to those that guided the modeling for CP1. Table 13-47 shows the changes in monthly flows that would occur under CP4. Therefore, this impact would be the same as Impact Wild-17 (CP1) and would be potentially significant for CP4. Mitigation for this impact is proposed in Section 13.3.5.

For CP4A, this impact would be similar to Impact Wild-17 (CP1). CP4A would affect habitat for sensitive species through the same pathways (alteration of off-channel habitat for western pond turtles, changes to successional patterns of vegetation) as discussed for CP1. The only difference between the two is the extent of the impact. Operation of CP4A would be identical to CP2, and the reductions in winter flows would be both more frequent and of larger magnitude than modeled to occur under CP1. In all water year types (except below-normal years and the Decembers of critical years), flows would be reduced by CP4A in December and January on average about 2.2 and 8.0 percent, respectively. In above-normal years, this would extend through February (-6.3 percent) and March (-5.2 percent) (see CP2 in Table 13-34). This impact would be potentially significant for CP4A. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-18 (CP4 and CP4A): Impacts on Bank Swallow in the Primary Study Area Resulting from Modifications of Geomorphic Processes The implementation of CP4 or CP4A would cause a small reduction in the magnitude, duration, and frequency of intermediate to large flows in the Sacramento River in the primary study area. This reduction also would alter the river's geomorphic processes, including the rate of bank erosion. However, the length of eroding banks would not be substantially altered, and thus, nesting habitat for bank swallows would not be substantially reduced. High flows during the nesting season that may cause localized nest failure would not be increased. The impact on habitat for bank swallow nesting colonies would be less than significant for CP4 or CP4A.

The operational rules that govern the management of reservoirs and delivery of water under CP4 are identical to those that guided the modeling for CP1. Therefore, this impact would be the same as Impact Wild-18 (CP1) and would be less than significant for CP4. Mitigation for this impact is proposed in Section 13.3.5.

For CP4A, the impact would be similar to Impact Wild-18 (CP1), but greater as in Impact Wild-18 (CP2). The extent of the impact could be greater under CP4A than under CP1 because reductions in channel-forming flows could be more extensive than under CP1. Nonetheless, for the same reasons as discussed for CP1, this impact would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact Wild-19 (CP4 and CP4A): Disturbance or Removal of Vernal Pool Habitat for Special-Status Wildlife from Dam Construction and from Changes in Flow Regime   As mentioned in Impact Wild-19 (CP1), vernal pools are generally not present within the active floodplain of the upper Sacramento River in the primary study area; vernal pools are found in upland locations outside of the main river channel and the floodplain. Thus, vernal pools are not anticipated to be affected by changes in flows that could result from implementation of CP4 or CP4A.

The operational rules that govern the management of reservoirs and delivery of water under CP4 are identical to those that guided the modeling for CP1. Therefore, this impact would be the same as Impact Wild-19 (CP1). Because CP4 would not affect vernal pool habitat or the sensitive wildlife species that occur within the habitat, no impact would occur. Mitigation for this impact is not needed, and thus not proposed.

The operational rules that govern the management of reservoirs and delivery of water under CP4A are identical to those that guided the modeling for CP2. Therefore, this impact would be the same as Impact Wild-19 (CP2). Because CP4A would not affect vernal pool habitat or the sensitive wildlife species that occur within the habitat, no impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Table 13-47. Percent Change in Average Monthly Flows at Keswick Dam and Downstream Under CP4

Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Keswick												
Wet	1.6%	0.8%	-6.0%	-2.9%	-0.5%	0.4%	0.3%	0.1%	0.2%	0.3%	0.3%	0.4%
Above Normal	5.1%	-1.5%	-1.4%	-2.2%	-5.2%	-2.2%	0.0%	-3.0%	-1.4%	0.1%	0.9%	5.9%
Below Normal	0.9%	-0.7%	0.1%	-0.9%	-0.7%	-1.1%	0.2%	-2.6%	1.1%	0.2%	0.0%	1.3%
Dry	2.4%	4.1%	-2.0%	-2.0%	-1.0%	0.0%	0.7%	1.4%	2.3%	1.5%	2.3%	3.9%
Critical	2.3%	4.8%	1.0%	-0.6%	1.7%	0.8%	1.0%	1.8%	0.6%	0.7%	-0.2%	5.6%
Bend Bridge												
Wet	1.4%	1.4%	-3.1%	-1.2%	-0.3%	0.3%	0.2%	0.1%	0.2%	0.3%	0.3%	0.4%
Above Normal	4.0%	-1.1%	-0.6%	-1.2%	-2.8%	-1.3%	0.0%	-2.1%	-1.0%	0.0%	0.8%	5.5%
Below Normal	0.8%	-0.1%	0.0%	-0.5%	-0.4%	-0.8%	0.1%	-1.6%	1.0%	0.2%	-0.1%	1.2%
Dry	2.1%	3.1%	-1.0%	-1.0%	-0.5%	0.0%	0.5%	1.1%	2.1%	1.5%	2.3%	3.6%
Critical	1.6%	3.9%	0.8%	-0.4%	1.5%	0.6%	0.8%	1.6%	0.5%	0.6%	-0.2%	5.2%
Butte City												
Wet	1.6%	2.0%	-2.3%	-0.7%	-0.2%	0.3%	0.1%	-0.1%	0.0%	0.2%	0.2%	0.4%
Above Normal	4.3%	-0.8%	-0.4%	-0.9%	-1.9%	-0.8%	0.2%	-2.4%	-1.2%	-0.3%	0.8%	5.8%
Below Normal	1.2%	0.2%	0.3%	-0.6%	-0.3%	-0.7%	-0.3%	-1.5%	1.4%	0.3%	0.0%	1.0%
Dry	2.4%	3.2%	-0.7%	-0.5%	-0.2%	0.0%	0.8%	1.0%	3.2%	2.3%	3.2%	3.8%
Critical	1.4%	4.3%	0.8%	-0.5%	1.4%	0.5%	1.1%	2.2%	0.6%	0.9%	-0.2%	4.8%
Wilkins Slough												
Wet	1.6%	2.2%	-1.6%	-0.2%	0.0%	0.3%	0.1%	-0.1%	0.0%	0.2%	0.2%	0.4%
Above Normal	4.3%	-0.8%	-0.4%	-0.6%	-1.1%	-0.4%	0.2%	-2.4%	-1.2%	-0.3%	0.8%	5.8%
Below Normal	1.2%	0.2%	0.3%	-0.6%	0.0%	-0.7%	-0.3%	-1.5%	1.4%	0.3%	0.0%	1.0%
Dry	2.4%	3.2%	-0.7%	-0.4%	-0.2%	0.0%	0.8%	1.0%	3.2%	2.3%	3.2%	3.8%
Critical	1.4%	4.3%	0.8%	-0.5%	1.4%	0.5%	1.1%	2.2%	0.6%	0.9%	-0.2%	4.8%
Verona												
Wet	1.5%	1.7%	-1.3%	-0.2%	0.0%	0.2%	0.1%	-0.2%	0.0%	0.1%	-0.1%	0.2%
Above Normal	3.2%	-0.1%	-0.3%	-0.4%	-1.3%	-0.2%	0.1%	-1.0%	-0.8%	-0.2%	0.4%	2.3%
Below Normal	0.6%	0.1%	-0.1%	0.0%	0.1%	-0.5%	-0.2%	-0.4%	1.4%	0.1%	-0.1%	-0.3%
Dry	1.3%	2.5%	-0.8%	-0.2%	-0.2%	0.0%	0.5%	0.7%	-1.0%	1.1%	1.8%	5.7%
Critical	0.5%	3.6%	0.8%	-0.2%	1.1%	0.4%	0.7%	2.0%	0.5%	0.8%	-1.5%	3.1%

Table 13-47. Percent Change in Average Monthly Flows at Keswick Dam and Downstream Under CP4 (contd.)

Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Freeport												
Wet	0.7%	0.5%	-0.3%	-0.2%	0.1%	0.1%	0.0%	-0.2%	0.0%	0.0%	0.0%	0.0%
Above Normal	1.2%	-0.5%	0.0%	0.0%	-0.5%	-0.1%	0.1%	-0.8%	-0.6%	-0.1%	0.0%	0.5%
Below Normal	-0.1%	-0.6%	0.5%	0.5%	0.3%	-0.3%	0.1%	-0.5%	0.3%	-0.1%	-0.4%	0.0%
Dry	1.2%	1.4%	-0.5%	-0.1%	-0.1%	-0.1%	0.2%	0.5%	-0.2%	0.7%	1.7%	4.3%
Critical	0.1%	1.8%	0.8%	-0.2%	0.9%	-0.1%	0.4%	0.9%	0.0%	1.4%	0.5%	2.4%

Impact Wild-20 (CP4 and CP4A): Consistency with Local and Regional Plans with Goals of Promoting Riparian Habitat in the Primary Study Area Several conservation and management plans have been adopted in the primary and extended study areas with goals of promoting riparian habitat along the Sacramento River. Because flow regimes and riverine geomorphic processes could be altered with project implementation, riparian habitat could be affected in such a manner that the goals of the local and regional plans would be more difficult to attain. Therefore, this impact would be potentially significant for CP4 or CP4A.

The operational rules that govern the management of reservoirs and delivery of water under CP4 are identical to those that guided the modeling for CP1. Therefore, this impact would be the same as Impact Wild-20 (CP1) and would be potentially significant for CP4. Mitigation for this impact is proposed in Section 13.3.5.

The operational rules that govern the management of reservoirs and delivery of water under CP4A are identical to those that guided the modeling for CP2. This impact would be similar to Impact Wild-20 (CP2). This impact would be potentially significant for CP4A. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-21 (CP4 and CP4A): Impacts on Riparian-Associated Special-Status Wildlife Resulting from the Gravel Augmentation Program CP4 and CP4A include a gravel augmentation program in the upper Sacramento River for fisheries benefit, as described in Chapter 2, "Alternatives." Implementing the gravel augmentation program could result in temporary and short-term disturbance of riparian vegetation that has the potential to support special-status wildlife. There are no vernal pools or other seasonal wetland habitats at the augmentation sites. However, riparian-associated special-status wildlife species could be killed during removal of riparian vegetation. This impact would be potentially significant for CP4 or CP4A.

The implementation of a gravel augmentation program in the upper Sacramento River for fisheries benefit could result in temporary disturbance of habitat or removal of riparian vegetation that has the potential to support special-status wildlife. Gravel augmentation would occur at one to three sites per year over a 10-year period, so the area of impact in a given year would be relatively small. Although a total of 15 potential augmentation sites have been identified between Keswick Dam and Shea Island, the choice of specific sites would be made annually through an agency consultation process that would minimize impacts and maximize benefits of the deposited gravel.

Gravel placement itself is not expected to result in substantial adverse effects on any wildlife species because the gravel would all be placed within the active stream channel where there are no vernal pools or other seasonal wetland habitats. The main avenue of impact for riparian-dependent species would be construction of access roads required to allow equipment to reach the river. This would be a short-term habitat loss that would not be sufficient to substantially affect any wildlife species. However, riparian-associated special-status wildlife species could be killed during riparian vegetation removal. Direct loss of riparian-associated special-status species during vegetation removal would be a potentially significant impact for CP4 or CP4A. Potential effects on special-status wildlife species are as follows:

- **Invertebrates –** Blue elderberry shrubs, the host plant for the valley elderberry longhorn beetle, are found throughout much of the Sacramento River's riparian corridor. Gravel augmentation activities have the potential to directly and indirectly affect blue elderberry shrubs, as well as valley elderberry longhorn beetles potentially present in the shrubs. Eleven individual elderberry shrubs and/or clumps are present within 100 feet of areas that would be disturbed during gravel augmentation; these shrubs are located 20 feet or more from the access trail. As currently designed, no elderberry shrub removal is required; the nearest project activity is restricted to use of the access trail. Should access routes need to be adjusted or elderberry shrubs become established in an access route between augmentation intervals, the resulting disturbance of elderberry shrubs would be a potentially significant impact.

- **Reptiles and Amphibians –** The western pond turtle has been documented within the Sacramento River and suitable habitat for the species is provided in the primary study area. Riparian vegetation that would be removed along the river corridor provides potential cover and foraging habitat for western pond turtle. Augmentation activities would take place during the western pond turtle's breeding season; thus, the potential also exists to affect nests, eggs, nesting females, or juvenile turtles during vegetation clearing, grading, and gravel placement. Therefore, loss of habitat for the western pond turtle would be a potentially significant impact.

- **Birds –** The riparian and wetland habitats along the Sacramento River floodway provide potential nesting and foraging habitat for western yellow-billed cuckoo, California yellow warbler, and yellow-breasted chat, all of which are special-status birds that nest in riparian vegetation. In addition, northern harrier and short-eared owl may nest in marshes in or adjacent to the stream channel. Other raptors (Cooper's hawk, Swainson's hawk, white-tailed kite, bald eagle, and osprey) may nest in trees in the riparian habitat in the study area. Gravel augmentation activities would be limited to a 1-month window from late August to September each year. Therefore, gravel augmentation would generally be conducted outside of the nesting season of most of these species. However, there would still be some potential for active nests to be present in gravel augmentation and vegetation removal areas until mid-September. For example, the nesting season for Swainson's hawk, white-tailed kite, and other raptors is from March 1 to September 15 and the nesting season of many other species extends through August 31. Therefore, vegetation removal or disturbance of active nests could result in direct mortality or loss or abandonment of active nests. This would be a potentially significant impact.

- **Mammals –** Special-status mammals potentially occurring in the project area include pallid bat, western red bat, and ringtail. Riparian habitat can provide important foraging and roosting habitat for bats, but while they may roost there, these species are not typically dependent on riparian habitats. The amount of potential foraging and roosting habitat would not substantially decrease, so impacts on special-status bats would be less than significant. Removal of small amounts of riparian vegetation along the river channel in the study area to create access routes for gravel augmentation would not substantially reduce habitat for ringtail. Therefore, impacts on special-status mammals would be less than significant.

Because creation and maintenance of access routes to gravel augmentation sites has the potential to affect valley elderberry longhorn beetle, western pond turtle, and riparian-associated special-status birds, the impact would be potentially significant for CP4 or CP4A. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-22 (CP4 and CP4A): Impacts on Riparian-Associated Special-Status Wildlife Species Resulting from Restoration Projects CP4 and CP4A include riparian, floodplain, and side-channel habitat restoration at one or a combination of potential locations along the upper Sacramento River for fisheries benefit. Restoration actions could require removing vegetation, site grading and excavation, and planting of riparian species. This could require the construction of access routes, the use of heavy equipment to excavate side channels and restore floodplains, and the installation of native riparian plant species when earth-moving is complete. Disturbances as a result of these restoration actions would generally be related to construction-related activities, and could potentially take years for the installed plants to recover to the degree that the new community would function as high-quality riparian habitat. Overall, restoration work could result in disturbance and short-term removal of riparian vegetation that support riparian-associated special-status wildlife species that could be killed during riparian vegetation removal. This impact would be potentially significant for CP4 or CP4A.

CP4 and CP4A include restoration actions at up to six proposed sites. Potential effects of these actions on special-status wildlife species are as follows:

- **Invertebrates –** Blue elderberry shrubs, the host plant for the valley elderberry longhorn beetle, are found throughout much of the Sacramento River's riparian corridor. Elderberry shrubs may be present at any of the six proposed sites but have been documented near the Henderson Open Space, Anderson Island, and Reading Island sites. Construction activities have the potential to directly and indirectly affect blue elderberry shrubs, as well as valley elderberry longhorn beetles potentially present in the shrubs. Disturbance of elderberry shrubs would be a potentially significant impact for CP4 or CP4A.

- **Reptiles and Amphibians –** The western pond turtle has been documented within the Sacramento River, and suitable habitat for the species is provided within the primary study area. Riparian vegetation that would be removed along the river corridor provides potential cover and foraging habitat for western pond turtle. Pond turtles may use the historic and partially or intermittently connected side channels found at most of the restoration sites. Enhancement of these channels to provide spawning habitat for Chinook salmon could alter the channels to the extent that they are unsuitable for western pond turtles. This would primarily occur through an increase in water velocities required for spawning salmon and removal of complex cover and basking sites that turtles require. Habitat restoration activities would take place during the western pond turtle's breeding season; thus, the potential also exists to affect nests, eggs, juveniles, nesting females, and non-nesting adults during vegetation clearing, grading, and gravel placement. Therefore, loss of habitat for the western pond turtle or direct impacts on turtles themselves would be a potentially significant impact for CP4 or CP4A.

- **Birds –** The riparian habitat along the Sacramento River provides potential nesting and foraging habitat for western yellow-billed cuckoo, California yellow warbler, and yellow-breasted chat, all of which are special-status birds that nest in riparian vegetation. In addition, northern harrier and short-eared owl may nest in marshes in or adjacent to the stream channel. Other raptors (e.g., Cooper's hawk, Swainson's hawk, white-tailed kite, bald eagle, and osprey) may nest in trees in the riparian habitat along these waterways. Bald eagles have been documented nesting at Reading Island and Kapusta Island. The streambanks at Tobiasson Island and Reading Island provide nesting habitat for bank swallows. The proposed restoration activities all would require removing existing riparian vegetation to allow access to the work areas, staging equipment, removing soil, and site grading. Although riparian vegetation would be replanted after site work is complete, the removal or disturbance of active nests could result in direct mortality or loss or abandonment of active nests. This would be a potentially significant impact for CP4 or CP4A.

- **Mammals** – Special-status mammals potentially occurring in the project area include pallid bat, western red bat, and ringtail. Riparian habitat can provide important foraging and roosting habitat for bats, but these species are not typically dependent on riparian habitats. The amount of potential foraging habitat would not decrease appreciably during restoration activities. Available riparian habitats would still be sufficient for roosting habitat, so impacts on special-status bats would be less than significant. Vegetation removal would occur at any of the sites proposed for restoration. Although ringtail are not reported in the CNDDB (2012) from any of these locations, this species is known to occur in riparian habitat. The amount of vegetation to be removed would not substantially reduce available habitat for ringtail in the vicinity of these sites. Removal of small amounts of riparian vegetation along the river corridor would not substantially reduce habitat for ringtail. Therefore, impacts on special-status mammals would be less than significant for CP4 or CP4A.

The majority of the impacts associated with special-status wildlife species in upper Sacramento River riparian areas would be for short durations during r construction, temporary impacts lasting for several years after restoration is complete. Eventually conditions at the restoration sites would likely be the same as, or higher quality than what currently exists at the sites. Because of the potential to affect valley elderberry longhorn beetle, western pond turtle, and riparian-associated special-status birds, this impact would be potentially significant for CP4 or CP4A. Mitigation for this impact is proposed in Section 13.3.5.

Lower Sacramento River and Delta

Impact Wild-23 (CP4 and CP4A): Impacts on Riparian-Associated and Aquatic Special-Status Wildlife Resulting from Modifications to Existing Flow Regimes in the Lower Sacramento River and Delta The implementation of CP4 or CP4A would modify the flow regime and would reduce the frequency, duration, and magnitude of intermediate to large flows in the lower Sacramento River during winter and spring in some years. It also would increase the volume of flows in fall of most years. Although this change in surface and subsurface hydrology would be of a smaller magnitude than in the upper Sacramento River, it could affect habitats adjacent to the river channel and the formation of off-channel habitats along the lower Sacramento River, which would adversely affect the habitat of western pond turtle. Although the total amount of riparian vegetation would not decline substantially, the portion in early successional stages would be reduced. These early successional stages provide habitat for some special-status wildlife species. These changes could result in substantial effects on the distribution or abundance of riparian-nesting special-status bird species. Because CP4 or CP4A would substantially alter habitat for a variety of riparian-dependent special-status species, this impact would be potentially significant for CP4 or CP4A.

The operational rules that govern the management of reservoirs and delivery of water under CP4 are identical to those that guided the modeling for CP1. Therefore, this impact would be the same as Impact Wild-23 (CP1) and would be potentially significant. Mitigation for this impact is proposed in Section 13.3.5.

The operational rules that govern the management of reservoirs and delivery of water under CP4A are identical to those that guided the modeling for CP2. For CP4A, this impact would be the same as Impact Wild-23 (CP2). Because CP4A could substantially reduce available habitat for special-status wildlife, this impact would be potentially significant. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-24 (CP4 and CP4A): Impacts on Bank Swallow Along the Lower Sacramento River Resulting from Modifications of Geomorphic Processes
Implementation of CP4 or CP4A would cause a small reduction in the magnitude, duration, and frequency of intermediate to large flows in the lower Sacramento River. This reduction also would alter the river's geomorphic processes. The rate of bank erosion would be reduced, but the length of eroding banks would not be substantially altered, and thus, nesting habitat for bank swallows would not decline substantially. High flows during the nesting season that may cause localized bank and nest failure would not increase. The impact on habitat for bank swallow nesting colonies, and therefore bank swallows themselves, would be less than significant for CP4 or CP4A.

The operational rules that govern the management of reservoirs and delivery of water under CP4 are identical to those that guided the modeling for CP1. The effect of CP4 on bank swallow habitat along the lower Sacramento River would be similar to the effect along the upper Sacramento River, but smaller because the effect of CP4 on river flows would attenuate with distance downstream. Therefore, this impact would be the same as Impact Wild-24 (CP1), and would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

The operational rules that govern the management of reservoirs and delivery of water under CP4A are identical to those that guided the modeling for CP2. This impact would be the same as Impact Wild-24 (CP2). The effect of CP4A on bank swallow habitat along the lower Sacramento River would be similar to the effect along the upper Sacramento River, but smaller because the effect of CP4A on river flows would attenuate with distance downstream. Because the extent of bank erosion and flooding of nesting sites is not expected to substantially change under CP4A, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Wild-25 (CP4 and CP4A): Disturbance or Removal of Vernal Pool Habitat for Special-Status Wildlife Along the Lower Sacramento River and in the Delta from Changes in Flow Regime of the Sacramento River and Affected

Tributaries, and Changes in Seasonal Water Availability Vernal pools are present in upland areas near the Sacramento River and its tributaries in the extended study area. These pools provide habitat for numerous special-status species. Critical habitat for three special-status species (vernal pool fairy shrimp, vernal pool tadpole shrimp, and Conservancy fairy shrimp) is located within the extended study area. Critical habitat for these species is confined to vernal pool communities (USFWS 2006). However, vernal pools are generally not present within the active floodplain of regulated rivers along the lower Sacramento River and in the Delta.

The operational rules that govern the management of reservoirs and delivery of water under CP4 are identical to those that guided the modeling for CP1. Because CP4 would not affect this habitat or these species, no impact would occur. Mitigation for this impact is not needed, and thus not proposed.

The operational rules that govern the management of reservoirs and delivery of water under CP4A are identical to those that guided the modeling for CP2. Because the sensitive habitat and species are located outside of the area affected by the changes in flows, CP4A would not alter this habitat. Therefore, no impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact Wild-26 (CP4 and CP4A): Consistency with Local and Regional Plans with Goals of Promoting Riparian Habitat along the Lower Sacramento River and in the Delta Several conservation and management plans have been adopted in the primary and extended study areas with goals of promoting riparian habitat along the Sacramento River. Because flow regimes and riverine geomorphic processes could be altered with project implementation, riparian habitat could be affected in such a manner that the goals of the local and regional plans would be more difficult to attain. Therefore, this impact would be potentially significant for CP4 or CP4A.

The operational rules that govern the management of reservoirs and delivery of water under CP4 are identical to those that guided the modeling for CP1. Therefore, this impact would be the same as Impact Wild-26 (CP1) and would be potentially significant. Mitigation for this impact is proposed in Section 13.3.5.

The operational rules that govern the management of reservoirs and delivery of water under CP4A are identical to those that guided the modeling for CP2. Therefore, this impact would be the same as Impact Wild-26 (CP1) and would be potentially significant. Mitigation for this impact is proposed in Section 13.3.5.

CVP/SWP Service Areas

Impact Wild-27 (CP4 and CP4A): Impacts on Riparian-Associated or Aquatic Special-Status Wildlife in the CVP/SWP Service Areas Resulting from

Modifications to Existing Flow Regimes By altering storage and operations at several reservoirs associated with the CVP and SWP service areas, CP4 or CP4A would change flow regimes in several downstream waterways. Modified flow regimes would reduce the frequency, duration, and magnitude of intermediate to large flows along the Sacramento River. The change in surface and subsurface hydrology could affect habitats adjacent to the river channel that provide habitat for special-status wildlife species. These changes are unlikely to result in substantial effects on the distribution or abundance of riparian-associated or aquatic special-status wildlife species in the CVP and SWP service areas outside of the primary study area. Therefore, this impact would be less than significant for CP4 or CP4A.

The operational rules that govern the management of reservoirs and delivery of water under CP4 are identical to those that guided the modeling for CP1. Therefore, this impact would be the same as Impact Wild-27 (CP1) and would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

For CP4A, this impact would be similar to Impact Wild-27 (CP2). The CVP and SWP are operated as an integrated system with the same downstream management targets and goals. CVP and SWP operations are constrained by the 2008 USFWS BO and the 2009 NMFS BO. Thus, implementation of CP4A is not anticipated to sufficiently alter flow to the CVP/SWP service areas to have a substantial effect on the riparian habitat upon which special-status wildlife species depend. For these reasons, this impact would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

CP5 – 18.5-Foot Dam Raise, Combination Plan

CP5 would address both the primary and secondary planning objectives. It involves enlarging Shasta Dam by 18.5 feet, which is consistent with the objectives of the 2000 CALFED Programmatic ROD, and also includes the common features described above. Affected wildlife acreages for CP5 are the same as described for CP4 and CP4A. In addition, CP5 involves (1) implementing environmental restoration features along the lower reaches of major tributaries to Shasta Lake, (2) constructing shoreline fish habitat around Shasta Lake, and (3) constructing either additional or improved recreation features at various locations around Shasta Lake to increase the value of the recreational experience. Formulation of specific environmental restoration features and increased recreation components is included in the Feasibility Report.

CP5 would also include implementing the same gravel augmentation program and the same riparian, floodplain, and side channel habitat restoration at up to six locations along the upper Sacramento River as described for CP4 and CP4A.

Shasta Lake and Vicinity

Impact Wild-1 (CP5): Take and Loss of Habitat for the Shasta Salamander Ground-disturbing activities associated with construction could result in direct take of the Shasta salamander, a State-listed species, USFS sensitive species, S&M species, MSCS-covered species, and BLM sensitive species. In addition, the raising of Shasta Dam would result in the inundation of habitat for this species. This impact would be significant.

This impact would be similar to Impact Wild-1 (CP3) and would be significant. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-2 (CP5): Impact on the Foothill Yellow-Legged Frog and Tailed Frog and Their Habitat Ground-disturbing activities associated with construction could result in direct take (e.g., because of operation of equipment in or adjacent to riverine or riparian habitat) of the foothill yellow-legged frog, a California species of special concern, a USFS sensitive species, an MSCS-covered species, and a BLM sensitive species, and of the tailed frog, a California species of special concern. In addition, the raising of Shasta Dam would result in the conversion of suitable riverine and riparian habitat to unsuitable lacustrine habitat. This impact would be potentially significant.

This impact would be similar to Impact Wild-2 (CP3) and would be potentially significant. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-3 (CP5): Impact on the Northwestern Pond Turtle and Its Habitat Ground-disturbing activities associated with construction could result in direct take (e.g., because of operation of equipment in or adjacent to riverine or riparian habitat) of the northwestern pond turtle, an MSCS-covered species, a California species of special concern, and a USFS sensitive species. In addition, project implementation could result in the degradation of suitable aquatic habitat because of increased erosion and sedimentation. This impact would be potentially significant.

This impact would be similar to Impact Wild-3 (CP3) and would be potentially significant. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-4 (CP5): Impact on the American Peregrine Falcon Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas during the nesting season could result in the incidental loss of fertile eggs or nestlings or otherwise lead to the abandonment of nests of American peregrine falcons, a State fully protected species and MSCS-covered species. This impact would be potentially significant.

This impact would be similar to Impact Wild-4 (CP3) and would be potentially significant. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-5 (CP5): Take and Loss of Habitat for the Bald Eagle Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas in addition to inundation caused by the raising of Shasta Dam during the nesting season would result in the loss of nest and perch trees used by the bald eagle, a State-listed species, fully protected species, and USFS sensitive species, an MSCS-covered species, and a BLM sensitive species. This impact would be significant.

This impact would be similar to Impact Wild-5 (CP3) and would be significant. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-6 (CP5): Take and Loss of Dispersal Habitat for the Northern Spotted Owl Construction activities and vegetation removal associated with the dam construction activities, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas would result in the loss of northern spotted owl dispersal habitat, a species Federally listed as threatened and an MSCS-covered species. This impact would be potentially significant.

This impact would be similar to Impact Wild-6 (CP3) and would be potentially significant. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-7 (CP5): Impact on the Purple Martin and Its Nesting Habitat Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas during the nesting season could result in the incidental loss of fertile eggs or nestlings or otherwise lead to the abandonment of nests of purple martins, a California species of special concern. In addition, inundation caused by the raising of Shasta Dam would result in the loss of nest trees. This impact would be significant.

This impact would be similar to Impact Wild-7 (CP3) and would be significant. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-8 (CP5): Impacts on the Willow Flycatcher, Vaux's Swift, Yellow Warbler, and Yellow-Breasted Chat and Their Foraging and Nesting Habitat Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas during the nesting season could result in the incidental loss of fertile eggs or nestlings or otherwise lead to the abandonment of nests of the willow flycatcher, a species State listed as endangered, USFS sensitive species, and MSCS-covered species; the Vaux's swift, a California species of special concern; and the yellow warbler and yellow-breasted chat, both California species of special concern and MSCS-covered species. In addition, the raising of Shasta Dam would result in the loss of habitat, including nesting habitat, for these species. This impact would be potentially significant.

This impact would be similar to Impact Wild-8 (CP3) and would be potentially significant. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-9 (CP5): Impacts on the Long-Eared Owl, Northern Goshawk, Cooper's Hawk, Great Blue Heron, and Osprey and Their Foraging and Nesting Habitat Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas during the nesting season could result in the incidental loss of fertile eggs or nestlings or otherwise lead to the abandonment of nests of the long-eared owl, a California species of special concern and an MSCS-covered species; the northern goshawk, a California species of special concern, a USFS sensitive species, and a BLM sensitive species; the Cooper's hawk, an MSCS-covered species; the great blue heron, an MSCS-covered species; and the osprey, an MSCS-covered species. In addition, the raising of Shasta Dam would result in the loss of foraging and nesting habitat for these species. This impact would be potentially significant.

This impact would be similar to Impact Wild-9 (CP3) and would be potentially significant. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-10 (CP5): Take and Loss of Habitat for the Pacific Fisher Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas would result in a loss of habitat for the Pacific fisher, a Federal candidate for listing, a California species of special concern, a USFS sensitive species, and a BLM sensitive species. Furthermore, take (including mortality of individuals because of destruction or disturbance of active roost sites or dens) could result from construction activities and vegetation clearing. This impact would be potentially significant.

This impact would be similar to Impact Wild-10 (CP3) and would be potentially significant. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-11 (CP5): Impacts on Special-Status Bats (Pallid Bat, Spotted Bat, Western Red Bat, Western Mastiff Bat, Townsend's Big-Eared Bat, Long-Eared Myotis, Yuma Myotis, and Fringed Myotis), the American Marten, and Ringtail and Their Habitat Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas would result in a loss of habitat for the pallid bat, a California species of special concern, a USFS sensitive species, and a BLM sensitive species; the western red bat, a USFS sensitive species; the western mastiff bat, a California species of special concern, an MSCS-covered species, and a BLM sensitive species; the Townsend's big-eared bat, a California species of special concern, a USFS sensitive species, and a BLM sensitive species; the long-eared myotis, a BLM sensitive species; the Yuma myotis, a BLM sensitive species; the fringed myotis, a USFS sensitive species; the American marten, a USFS sensitive species; and the ringtail, a State fully protected and MSCS-covered species. Furthermore, take (including mortality of individuals because of destruction or disturbance of active roost sites or dens) could result from construction activities and vegetation clearing. This impact would be potentially significant.

This impact would be similar to Impact Wild-11 (CP3) and would be potentially significant. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-12 (CP5): Impacts on Special-Status Terrestrial Mollusks (Church's Sideband, Shasta Sideband, Wintu Sideband, Oregon Shoulderband, Shasta Chaparral, and Shasta Hesperian) and Their Habitat All of these species are designated USFS sensitive and/or S&M species, and the Shasta sideband is also an MSCS-covered species. The Shasta Sideband, Wintu Sideband, Shasta Chaparral, and Shasta Hesperian are also petitioned for Federal listing. Ground-disturbing activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas could result in direct take and/or loss of suitable habitat for special-status terrestrial mollusks. In addition, the raising of Shasta Dam would result in the inundation of suitable habitat and direct take of these species. This would be a significant impact.

This impact would be similar to Impact Wild-12 (CP3) and would be a significant impact. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-13 (CP5): Permanent Loss of General Wildlife Habitat and Western Bumble Bee Habitat Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas would result in a permanent loss of habitat. In addition, inundation caused by the raising of Shasta Dam would result in a permanent loss of habitat. This would be a potentially significant impact.

This impact would be similar to Impact Wild-13 (CP3) and would be potentially significant. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-14 (CP5): Impacts on Other Birds of Prey (e.g., red-tailed hawk and red-shouldered hawk) and Migratory Bird Species (e.g., American robin, Anna's hummingbird) and their Foraging and Nesting Habitat Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas during the nesting season could result in the incidental loss of fertile eggs or nestlings or otherwise lead to the abandonment of nests of other birds of prey and migratory bird species. In addition, inundation caused by the raising of Shasta Dam could result in the loss of active nests and habitat for these species. This impact would be potentially significant.

This impact would be similar to Impact Wild-14 (CP3) and would be potentially significant. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-15 (CP5): Loss of Critical Deer Winter and Fawning Range Construction activities and vegetation removal associated with raising the dam, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas would result in a loss of critical deer winter and fawning range. In addition, inundation caused by the raising of Shasta Dam would result in the loss of critical deer range. This would be a potentially significant impact.

This impact would be similar to Impact Wild-15 (CP3) and would be potentially significant. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-16 (CP5): Take and Loss of the California Red-Legged Frog Reclamation completed California red-legged frog habitat assessments in coordination with the USFWS in the applicable impoundment and relocations areas, and the potential downstream Sacramento River restoration sites. The assessment results will enable Reclamation and the USFWS to determine if habitat for the species occurs, if impacts are anticipated, and if additional surveys are needed. Impacts on the California red-legged frog will be assessed if surveys are conducted and the California red-legged frog is found. Impacts for each alternative will not be assessed until USFWS has determined whether suitable habitat is present and whether surveys would be required. Mitigation for this impact is discussed in Section 13.3.5.

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact Wild-17 (CP5): Impacts on Riparian-Associated Special-Status Wildlife Resulting from Modifications to the Existing Flow Regime in the Primary Study Area Implementing CP5 would increase available water storage in Shasta Reservoir and result in a modified flow regime. This modification would reduce the frequency, duration, and magnitude of intermediate to large flows downstream from Shasta Dam during winter and spring in some water years, and would increase the volume of flows in fall of most years. This change in surface and subsurface hydrology could affect habitats adjacent to the river channel and reduce the formation of off-channel habitats, which would adversely affect the habitat of western pond turtle. Although the total amount of riparian vegetation would not decline substantially, the portion in early successional stages would be reduced. These early successional stages provide habitat for some special-status wildlife species. These changes could result in substantial effects on the distribution or abundance of riparian-nesting special-status bird species. Because CP5 would substantially alter habitat for a variety of riparian-dependent special-status species, this impact would be potentially significant.

This impact would be similar to Impact Wild-17 (CP1). The pathways by which sensitive species would be affected under CP5 are similar to those for CP1. The differences are in the magnitude of changes. For example, implementing CP5 would result in a reduction in average monthly flow downstream from Keswick Dam of between 2 and 10 percent in December of dry through wet water year types; similar although smaller reductions extend through March (Table 13-48). Because one of the goals of CP5 is increased water supply reliability, average monthly flows in critical water years are generally increased under CP5. As modeled, average monthly flows are substantially higher in April through August of dry water years and in September and October under most types of water years. Sensitive species could be affected by these changes through flow-caused alteration of riparian habitat and altered flow regimes. Because the changes would be substantial, they could result in increased mortality or reductions in reproductive success. Therefore, this impact would be potentially significant. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-18 (CP5): Impacts on Bank Swallow in the Primary Study Area Resulting from Modifications of Geomorphic Processes Implementing CP5 would cause a small reduction in the magnitude, duration, and frequency of intermediate to large flows in the Sacramento River in the primary study area. This reduction also would alter the river's geomorphic processes, including the rate of bank erosion. However, the length of eroding banks would not be substantially altered, and thus, nesting habitat for bank swallows would not decline substantially. Therefore, the impact on habitat for bank swallow nesting colonies and the colonies themselves would be less than significant.

This impact would be the same as Impact Wild-18 (CP3). Modeling for CP5 predicts that increases in water surface elevation during the bank swallow nesting season would be at most an average of about 5–6 inches. These increases are not high enough that they would be expected to substantially increase the rate of localized nest failure. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Wild-19 (CP5): Disturbance or Removal of Vernal Pool Habitat for Special-Status Wildlife from Dam Construction and from Changes in Flow Regime As mentioned in Impact Wild-19 (CP1), vernal pools are generally not present within the active floodplain of the upper Sacramento River in the primary study area; vernal pools are found in upland locations outside of the main river channel and the floodplain. Thus, vernal pools are not anticipated to be affected by changes in flows that could result from implementation of CP5. Because CP5 would not affect vernal pool habitat or the species that occur within the habitat, no impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Table 13-48. Percent Change in Average Monthly Flows at Keswick Dam and Downstream Under CP5

Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Keswick												
Wet	1.6%	1.7%	-9.9%	-6.4%	-2.0%	0.3%	0.3%	0.5%	0.7%	0.3%	0.5%	2.8%
Above Normal	5.8%	1.0%	-3.7%	-3.2%	-7.0%	-8.0%	0.2%	-2.3%	-3.1%	0.3%	0.9%	10.2%
Below Normal	1.8%	-1.1%	-2.1%	-1.5%	-1.4%	-2.3%	1.1%	-3.3%	-0.6%	0.8%	0.8%	1.9%
Dry	6.4%	6.1%	-2.7%	-3.3%	-1.8%	0.0%	2.5%	3.9%	6.0%	3.7%	8.0%	8.8%
Critical	5.1%	7.1%	2.8%	2.8%	1.4%	1.0%	0.8%	1.1%	0.9%	4.6%	-1.5%	14.1%
Bend Bridge												
Wet	1.5%	2.0%	-5.2%	-2.8%	-1.2%	0.3%	0.2%	0.4%	0.6%	0.3%	0.5%	2.4%
Above Normal	4.7%	0.0%	-1.5%	-1.8%	-4.0%	-4.5%	0.1%	-1.5%	-2.3%	0.2%	0.8%	9.7%
Below Normal	1.5%	-0.5%	-1.3%	-0.8%	-0.8%	-1.7%	0.9%	-2.1%	-0.3%	0.7%	0.7%	1.6%
Dry	5.3%	5.3%	-1.4%	-1.6%	-1.0%	0.0%	2.0%	3.2%	5.6%	3.6%	7.8%	8.1%
Critical	3.9%	5.7%	2.4%	2.4%	1.2%	0.7%	0.6%	1.0%	0.9%	4.5%	-1.5%	12.9%
Butte City												
Wet	1.8%	2.7%	-3.9%	-1.7%	-0.8%	0.2%	0.2%	0.0%	0.2%	-0.2%	0.2%	2.3%
Above Normal	5.2%	0.3%	-1.2%	-1.2%	-3.1%	-2.9%	0.2%	-2.1%	-2.9%	-0.3%	0.6%	10.5%
Below Normal	1.7%	-0.3%	-1.1%	-1.0%	-0.5%	-1.5%	0.7%	-2.2%	-0.9%	0.5%	0.0%	1.1%
Dry	5.9%	5.8%	-1.0%	-1.0%	-0.4%	-0.1%	2.7%	2.9%	7.6%	4.3%	10.4%	7.9%
Critical	3.9%	6.2%	2.7%	2.0%	1.2%	0.6%	0.8%	1.5%	1.2%	6.8%	-1.7%	12.8%
Wilkins Slough												
Wet	1.8%	2.9%	-2.3%	-0.8%	-0.2%	0.3%	0.2%	0.0%	0.2%	-0.2%	0.2%	2.3%
Above Normal	5.2%	0.3%	-1.2%	-0.8%	-1.5%	-1.5%	0.2%	-2.1%	-2.9%	-0.3%	0.6%	10.5%
Below Normal	1.7%	-0.3%	-0.4%	-1.0%	0.0%	-1.5%	0.7%	-2.2%	-0.9%	0.5%	0.0%	1.1%
Dry	5.9%	5.8%	-1.0%	-0.9%	-0.4%	-0.1%	2.7%	2.9%	7.6%	4.3%	10.4%	7.9%
Critical	3.9%	6.2%	2.7%	2.0%	1.2%	0.6%	0.8%	1.5%	1.2%	6.8%	-1.7%	12.8%
Verona												
Wet	0.5%	2.2%	-2.3%	-0.6%	-0.1%	0.2%	0.1%	-0.1%	0.2%	-0.3%	-0.3%	1.0%
Above Normal	3.5%	1.1%	-1.0%	-0.5%	-2.1%	-0.9%	0.1%	-0.7%	-1.7%	-0.1%	0.3%	4.2%
Below Normal	1.9%	0.8%	-0.3%	-0.3%	-0.1%	-1.0%	0.5%	-0.8%	-0.1%	0.3%	0.0%	0.2%
Dry	3.9%	4.4%	-1.0%	-0.5%	-0.5%	-0.1%	1.6%	1.8%	-1.2%	3.4%	6.2%	9.2%
Critical	0.9%	5.5%	2.2%	2.0%	0.7%	0.3%	0.5%	1.8%	1.5%	8.2%	-4.7%	7.9%

Table 13-48. Percent Change in Average Monthly Flows at Keswick Dam and Downstream Under CP5 (contd.)

Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Freeport												
Wet	0.8%	0.5%	-0.5%	-0.6%	0.0%	0.1%	0.0%	-0.1%	0.1%	-0.2%	-0.2%	0.4%
Above Normal	2.2%	-0.8%	-0.4%	0.2%	-0.7%	-0.7%	0.1%	-0.5%	-1.4%	-0.2%	0.1%	0.6%
Below Normal	0.8%	0.0%	0.5%	0.5%	0.1%	-0.9%	0.6%	-1.0%	-0.8%	-0.1%	-0.4%	0.7%
Dry	2.6%	3.1%	-0.7%	-0.3%	-0.2%	0.1%	1.4%	1.5%	-0.6%	2.4%	5.2%	7.5%
Critical	-0.3%	3.1%	2.1%	1.8%	0.5%	-0.1%	0.3%	0.4%	0.0%	3.9%	-0.4%	5.9%

Impact Wild-20 (CP5): Consistency with Local and Regional Plans with Goals of Promoting Riparian Habitat in the Primary Study Area Several conservation and management plans have been adopted in the primary and extended study areas with goals of promoting riparian habitat along the Sacramento River. Because flow regimes and riverine geomorphic processes could be altered with project implementation, riparian habitat could be affected in such a manner that the goals of the local and regional plans would be more difficult to attain. Therefore, this impact would be potentially significant.

This impact would be the same as Impact Wild-20 (CP1) and would be potentially significant. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-21 (CP5): Impacts on Riparian-Associated Special-Status Wildlife Resulting from the Gravel Augmentation Program CP5 includes the gravel augmentation program. Implementing the gravel augmentation program could result in temporary and short-term disturbance or removal of riparian vegetation that has the potential to support special-status wildlife. Gravel augmentation would occur at one to three sites per year over a 10-year period (distributed at up to 15 different sites overall), so the area of impact in a given year would be very small. Thus, gravel placement is not expected to result in any substantial short- or long-term adverse effects on any wildlife species. However, riparian-associated special-status wildlife species could be killed during disturbance or removal of riparian vegetation. This impact would be potentially significant.

This impact would be the same as Impact Wild-21 (CP4 and CP4A) and would be potentially significant. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-22 (CP5): Impacts on Riparian-Associated Special-Status Wildlife Species Resulting from Restoration Projects Under CP5, riparian, floodplain, and side-channel habitat restoration would occur at one or a combination of potential locations along the upper Sacramento River. Restoration measures for the six potential restoration sites would generally involve riparian, floodplain, and side-channel restoration. Restoration actions could require removing vegetation, site grading and excavation, and planting riparian species. This could require the construction of access routes, use of heavy equipment to excavate side channels and restore floodplains, and installation of native riparian plant species when earth-moving is complete, Disturbances would generally be related to construction-related activities, but it would take years for the installed plants to recover to the degree that the new community would function as high-quality riparian habitat. Overall, restoration work could result in disturbance and short-term removal of riparian vegetation that support riparian-associated special-status wildlife species that could be killed during riparian vegetation removal. This impact would be potentially significant.

This impact would be the same as Impact Wild-22 (CP4 and CP4A) and would be potentially significant. Mitigation for this impact is proposed in Section 13.3.5.

Lower Sacramento River and Delta

Impact Wild-23 (CP5): Impacts on Riparian-Associated and Aquatic Special-Status Wildlife Resulting from Modifications to Existing Flow Regimes in the Lower Sacramento River and Delta Implementing CP5 would modify the flow regime and would reduce the frequency, duration, and magnitude of intermediate to large flows in the lower Sacramento River during winter and spring in some years. It also would increase the volume of flows in fall of most years. Although this change in surface and subsurface hydrology would be of smaller magnitude than in the upper Sacramento River, it could affect habitats adjacent to the river channel and the formation of off-channel habitats along the lower Sacramento River, which would adversely affect the habitat of western pond turtle. Although the total amount of riparian vegetation would not decline substantially, the portion in early successional stages would be reduced. These early successional stages provide habitat for some special-status wildlife species. These changes could result in substantial effects on the distribution or abundance of riparian-nesting special-status bird species. Because CP5 would substantially alter habitat for a variety of riparian-dependent special-status species, this impact would be potentially significant.

This impact would be the same as Impact Wild-23 (CP1). The pathways of the impact under CP5 would be the same as those under CP1. Because flows would be substantially altered under CP5, impacts on sensitive riparian-dependent species would be potentially significant. Mitigation for this impact is proposed in Section 13.3.5.

Impact Wild-24 (CP5): Impacts on Bank Swallow Along the Lower Sacramento River Resulting from Modifications of Geomorphic Processes Implementing CP5 would cause a small reduction in the magnitude, duration, and frequency of intermediate to large flows in the lower Sacramento River. This reduction also would alter the river's geomorphic processes. The rate of bank erosion would be reduced, but the length of eroding banks would not be substantially altered, and thus, nesting habitat for bank swallows would not decline substantially. High flows during the nesting season that may cause localized bank and nest failure would not increase. The impact on habitat for bank swallow nesting colonies, and therefore bank swallows themselves, would be less than significant.

This impact would be the same as Impact Wild-24 (CP1). The pathways of the impact under CP5 would be the same as those under CP1. The effect of CP5 on bank swallow habitat along the lower Sacramento River would be similar to the effect along the upper Sacramento River, but smaller because the effect of CP5 on river flows would attenuate somewhat with distance downstream. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Wild-25 (CP5): Disturbance or Removal of Vernal Pool Habitat for Special-Status Wildlife Along the Lower Sacramento River and in the Delta from Changes in Flow Regime of the Sacramento River and Affected Tributaries, and Changes in Seasonal Water Availability Vernal pools are present in upland areas near the Sacramento River and its tributaries in the extended study area. These pools provide habitat for numerous special-status species. Critical habitat for three special-status species (vernal pool fairy shrimp, vernal pool tadpole shrimp, and Conservancy fairy shrimp) is located within the extended study area. Critical habitat for these species is confined to vernal pool communities (USFWS 2006). However, vernal pools are generally not present within the active floodplain of regulated rivers along the lower Sacramento River and in the Delta. Because the sensitive habitat and species are located outside of the area affected by the changes in flows, CP5 would not alter this habitat. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact Wild-26 (CP5): Consistency with Local and Regional Plans with Goals of Promoting Riparian Habitat along the Lower Sacramento River and in the Delta Several conservation and management plans have been adopted in the primary and extended study areas with goals of promoting riparian habitat along the Sacramento River. Because flow regimes and riverine geomorphic processes could be altered with project implementation, riparian habitat could be affected in such a manner that the goals of the local and regional plans would be more difficult to attain. Therefore, this impact would be potentially significant.

This impact would be the same as Impact Wild-26 (CP1) and would be potentially significant. Mitigation for this impact is proposed in Section 13.3.5.

CVP/SWP Service Areas

Impact Wild-27 (CP5): Impacts on Riparian-Associated or Aquatic Special-Status Wildlife in the CVP/SWP Service Areas Resulting from Modifications to Existing Flow Regimes By altering storage and operations at several reservoirs associated with the CVP and SWP service areas, CP5 would change flow regimes in several downstream waterways. The change in surface and subsurface hydrology could affect habitats adjacent to the river channel that provide habitat for special-status wildlife species. These changes are unlikely to result in substantial effects on the distribution or abundance of riparian-associated or aquatic special-status wildlife species in the CVP and SWP service areas outside of the primary study area. Therefore, this impact would be less than significant.

This impact is similar to Impact Wild-27 (CP1). Modified flow regimes under CP5 would reduce the frequency, duration, and magnitude of intermediate to large flows along the Sacramento River. Most potential noticeable changes in flows and stages would diminish downstream from Red Bluff, but substantial changes are predicted in the Sacramento River downstream as far as Freeport in some water years (Table 13-48). The CVP and SWP are operated as an integrated system with the same downstream management targets and goals. CVP and SWP operations are constrained by the 2008 USFWS BO and the 2009 NMFS BO. Thus, this alternative is not anticipated to sufficiently alter flow to the CVP/SWP service areas to have a substantial effect on riparian habitat upon which special-status wildlife species depend. Therefore, this impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

13.3.5 Mitigation Measures

Table 13-49 presents a summary of mitigation measures for wildlife resources.

No-Action Alternative

No mitigation measures are required for this alternative.

CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

No mitigation is required for Impacts Wild-18 (CP1), Wild-19 (CP1), Wild-21 (CP1), Wild-22 (CP1), Wild-24 (CP1), Wild-25 (CP1), and Wild-27 (CP1). Mitigation is provided below for the remaining impacts of CP1 on wildlife species.

Table 13-49. Summary of Mitigation Measures for Wildlife Resources

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/CP4A	CP5
Impact Wild-1: Take and Loss of Habitat for the Shasta Salamander	LOS before Mitigation	NI	S	S	S	S	S
	Mitigation Measure	None required.	Mitigation Measure Wild-1: Avoid, Relocate, and Acquire Mitigation Lands for Shasta Salamander.				
	LOS after Mitigation	NI	SU	SU	SU	SU	SU
Impact Wild-2: Impact on the Foothill Yellow-Legged Frog and Tailed Frog and Their Habitat	LOS before Mitigation	NI	PS	PS	PS	PS	PS
	Mitigation Measure	None required.	Mitigation Measure Wild-2: Avoid, Relocate, and Acquire Mitigation Lands for Foothill Yellow-Legged Frog and Tailed Frog.				
	LOS after Mitigation	NI	SU	SU	SU	SU	SU
Impact Wild-3: Impact on the Northwestern Pond Turtle and Its Habitat	LOS before Mitigation	NI	PS	PS	PS	PS	PS
	Mitigation Measure	None required.	Mitigation Measure Wild-3: Avoid, Relocate, and Acquire Mitigation Lands for Northwestern Pond Turtle.				
	LOS after Mitigation	NI	SU	SU	SU	SU	SU
Impact Wild-4: Impact on the American Peregrine Falcon	LOS before Mitigation	NI	PS	PS	PS	PS	PS
	Mitigation Measure	None required.	Mitigation Measure Wild-4: Conduct Preconstruction Surveys for the American Peregrine Falcon and Establish Buffers.				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS

Table 13-49. Summary of Mitigation Measures for Wildlife Resources (contd.)

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/CP4A	CP5
Impact Wild-5: Take and Loss of Habitat for the Bald Eagle	LOS before Mitigation	NI	S	S	S	S	S
	Mitigation Measure	None required.	Mitigation Measure Wild-5: Acquire and Preserve Mitigation Lands; Conduct Protocol-Level Surveys for the Bald Eagle and Establish Buffers.				
	LOS after Mitigation	NI	SU	SU	SU	SU	SU
Impact Wild-6: Loss of Dispersal Habitat for the Northern Spotted Owl	LOS before Mitigation	NI	PS	PS	PS	PS	PS
	Mitigation Measure	None required.	Mitigation Measure Wild-6: Acquire and Preserve Mitigation Lands, Habitat Enhancement.				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS
Impact Wild-7: Impact on the Purple Martin and Its Habitat	LOS before Mitigation	NI	S	S	S	S	S
	Mitigation Measure	None required.	Mitigation Measure Wild-7: Conduct a Preconstruction Survey for the Purple Martin and Establish Buffers.				
	LOS after Mitigation	NI	SU	SU	SU	SU	SU
Impact Wild-8: Impacts on the Willow Flycatcher, Vaux's Swift, Yellow Warbler, and Yellow-Breasted Chat and Their Foraging and Nesting Habitat	LOS before Mitigation	NI	PS	PS	PS	PS	PS
	Mitigation Measure	None required.	Mitigation Measure Wild-8: Acquire and Preserve Mitigation Lands; Conduct a Preconstruction Survey for the Willow Flycatcher, Vaux's Swift, Yellow Warbler, and Yellow-Breasted Chat and Establish Buffers.				
	LOS after Mitigation	NI	SU	SU	SU	SU	SU

Table 13-49. Summary of Mitigation Measures for Wildlife Resources (contd.)

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/CP4A	CP5
Impact Wild-9: Impacts on the Long-Eared Owl, Northern Goshawk, Cooper's Hawk, Great Blue Heron, and Osprey and Their Foraging and Nesting Habitat	LOS before Mitigation	NI	PS	PS	PS	PS	PS
	Mitigation Measure						
	LOS after Mitigation	NI	SU	SU	SU	SU	SU
Impact Wild-10: Take and Loss of Habitat for the Pacific Fisher	LOS before Mitigation	NI	PS	PS	PS	PS	PS
	Mitigation Measure	None required.	Mitigation Measure Wild-10: Acquire and Preserve Mitigation Lands; Conduct Preconstruction Surveys for the Pacific Fisher and Establish Buffers.				
	LOS after Mitigation	NI	SU	SU	SU	SU	SU
Impact Wild-11: Impacts on Special-Status Bats (Pallid Bat, Spotted Bat, Western Red Bat, Western Mastiff Bat, Townsend's Big-Eared Bat, Long-Eared Myotis, and Yuma Myotis), the American Marten, and Ringtails and Their Habitat	LOS before Mitigation	NI	PS	PS	PS	PS	PS
	Mitigation Measure	None required.	Mitigation Measure Wild-11: Acquire and Preserve Mitigation Lands; Conduct a Preconstruction Survey for Special-Status Bats, American Marten, and Ringtails and Establish Buffers.				
	LOS after Mitigation	NI	SU	SU	SU	SU	SU
Impact Wild-12: Impacts on Special-Status Terrestrial Mollusks (Shasta Sideband, Wintu Sideband, Shasta Chaparral, and Shasta Hesperian) and Their Habitat	LOS before Mitigation	NI	S	S	S	S	S
	Mitigation Measure	None required.	Mitigation Measure Wild-12: Avoid Suitable Habitat; Acquire and Preserve Mitigation Lands for Special-Status Terrestrial Mollusks.				
	LOS after Mitigation	NI	SU	SU	SU	SU	SU

Table 13-49. Summary of Mitigation Measures for Wildlife Resources (contd.)

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/CP4A	CP5
Impact Wild-13: Permanent Loss of General Wildlife Habitat	LOS before Mitigation	NI	PS	PS	PS	PS	PS
	Mitigation Measure	None required.	Mitigation Measure Wild-13: Acquire and Preserve Mitigation Lands for Permanent Loss of General Wildlife Habitat.				
	LOS after Mitigation	NI	SU	SU	SU	SU	SU
Impact Wild-14: Impacts on Other Birds of Prey (i.e., Red-Tailed Hawk and Red-Shouldered Hawk) and Migratory Bird Species (i.e., American Robin, Anna's Hummingbird) and Their Foraging and Nesting Habitat	LOS before Mitigation	NI	PS	PS	PS	PS	PS
	Mitigation Measure	None required.	Mitigation Measure Wild-14: Acquire and Preserve Mitigation Lands and Conduct Preconstruction Surveys for Other Nesting Raptors and Migratory Birds and Establish Buffers.				
	LOS after Mitigation	NI	SU	SU	SU	SU	SU
Impact Wild-15: Loss of Critical Deer Winter and Fawning Range	LOS before Mitigation	NI	PS	PS	PS	PS	PS
	Mitigation Measure	None required.	Mitigation Measure Wild-15: Acquire and Preserve Mitigation Lands for Permanent Loss of Critical Deer Wintering and Fawning Range.				
	LOS after Mitigation	NI	SU	SU	SU	SU	SU
Impact Wild-16: Take and Loss of the California Red-Legged Frog	LOS before Mitigation	NI	TBD	TBD	TBD	TBD	TBD
	Mitigation Measure	None required.	TBD				
	LOS after Mitigation	NI	TBD	TBD	TBD	TBD	TBD

Table 13-49. Summary of Mitigation Measures for Wildlife Resources (contd.)

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/CP4A	CP5
Impact Wild-17: Impacts on Riparian-Associated Special-Status Wildlife Resulting from Modifications to the Existing Flow Regime in the Primary Study Area	LOS before Mitigation	LTS	PS	PS	PS	PS	PS
	Mitigation Measure	None required.	Mitigation Measure Wild-17: Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities.				
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
Impact Wild-18: Impacts on Bank Swallow in the Primary Study Area Resulting from Modifications of Geomorphic Processes	LOS before Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
Impact Wild-19: Disturbance or Removal of Vernal Pool Habitat for Special-Status Wildlife from Changes in Flow Regime	LOS before Mitigation	NI	NI	NI	NI	NI	NI
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	NI	NI	NI	NI	NI	NI
Impact Wild-20: Consistency with Local and Regional Plans with Goals of Promoting Riparian Habitat in the Primary Study Area	LOS before Mitigation	NI	PS	PS	PS	PS	PS
	Mitigation Measure	None required.	Mitigation Measure Wild-20: Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities.				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS

Table 13-49. Summary of Mitigation Measures for Wildlife Resources (contd.)

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/CP4A	CP5
Impact Wild-21: Impacts on Riparian-Associated Special-Status Wildlife Resulting from the Gravel Augmentation Program	LOS before Mitigation	NI	NI	NI	NI	PS	PS
	Mitigation Measure	None required.	None needed; thus, none proposed.			Mitigation Measure Wild-21: Conduct Preconstruction Surveys for Elderberry Shrubs, Northwestern Pond Turtle, and Nesting Riparian Raptors and Other Nesting Birds. Avoid Removal or Degradation of Elderberry Shrubs and Avoid Vegetation Removal near Active Nest Sites.	
	LOS after Mitigation	NI	NI	NI	NI	LTS	LTS
Impact Wild-22: Impacts on Riparian-Associated Special-Status Wildlife Species Resulting from Restoration at Reading Island	LOS before Mitigation	NI	NI	NI	NI	PS	PS
	Mitigation Measure	None required.	None needed; thus, none proposed.			Mitigation Measure Wild-22: Implement Mitigation Measure Wild-21: Conduct Preconstruction Surveys for Elderberry Shrubs, Northwestern Pond Turtle, and Nesting Riparian Raptors and Other Nesting Birds. Avoid Removal or Degradation of Elderberry Shrubs and Avoid Vegetation Removal near Active Nest Sites.	
	LOS after Mitigation	NI	NI	NI	NI	LTS	LTS
Impact Wild-23: Impacts on Riparian-Associated and Aquatic Special-Status Wildlife Resulting from Modifications to Existing Flow Regimes in the Lower Sacramento River and Delta	LOS before Mitigation	LTS	PS	PS	PS	PS	PS
	Mitigation Measure	None required.	Mitigation Measure Wild-23: Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities.				
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS

Table 13-49. Summary of Mitigation Measures for Wildlife Resources (contd.)

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/CP4A	CP5
Impact Wild-24: Impacts on Bank Swallow Along the Lower Sacramento River Resulting from Modifications of Geomorphic Processes	LOS before Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
Impact Wild-25: Disturbance or Removal of Vernal Pool Habitat for Special-Status Wildlife Along the Lower Sacramento River and in the Delta from Changes in Flow Regime of the Sacramento River and Affected Tributaries, and Changes in Seasonal Water Availability	LOS before Mitigation	NI	NI	NI	NI	NI	NI
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	NI	NI	NI	NI	NI	NI
Impact Wild-26: Consistency with Local and Regional Plans with Goals of Promoting Riparian Habitat along the Lower Sacramento River and in the Delta	LOS before Mitigation	NI	PS	PS	PS	PS	PS
	Mitigation Measure	None required.	Mitigation Measure Wild-26: Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities.				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS

Table 13-49. Summary of Mitigation Measures for Wildlife Resources (contd.)

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/CP4A	CP5
Impact Wild-27: Impacts on Riparian-Associated or Aquatic Special-Status Wildlife in the CVP/SWP Service Areas Resulting from Modifications to Existing Flow Regimes	LOS before Mitigation	LTS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	LTS	LTS	LTS	LTS	LTS	LTS

Key:
CP = Comprehensive Plan
LOS = level of significance
LTS = less than significant
NI = no impact
PS = potentially significant
S = significant
SU = significant and unavoidable
TBD = to be determined

Mitigation Measure Wild-1 (CP1): Avoid, Relocate, and Acquire Mitigation Lands for Shasta Salamander As described in the Preliminary Environmental Commitments and Mitigation Plan Appendix, Reclamation convened an interagency working group to enhance mitigation measures presented in the DEIS. This working group had the benefit of additional information from recent investigations of nearby private lands available for mitigation and refined analyses of potential project impacts. Using this updated information the working group developed and refined mitigation measures for wildlife resources, including land acquisition, habitat management and enhancement, and other measures.

Mitigation measure Wild-1 consists of a program to acquire nearby private lands with similar habitat attributes and species composition as those impacted by the SLWRI project. Reclamation has identified several willing private landowners and specific parcels for purchase in the SLWRI project area vicinity. Preliminary investigations of these lands have shown they contain similar and/or additional habitats and special-status species as those impacted by SLWRI. Special-status wildlife species known to occur on the lands subject to these preliminary investigations include Church's sideband, Klamath shoulderband, Shasta chaparral, Shasta sideband, Shasta hesperian, Shasta salamander, foothill yellow-legged frog, bald eagle, and Pacific fisher. Additionally, the interagency working group identified other private parcels with similar biological resources in the vicinity of the SLWRI project area, some of which have owners willing to discuss purchase agreements.

As discussed during the interagency working group meetings, mitigation measure Wild-3 will begin with a 3:1 minimum replacement ratio of acquired lands to impacted lands. The interagency working group also agreed that additional considerations will be made for other replacement ratios (more or less), depending on habitat quality at a particular site. Emphasis will be placed on lands containing high-value habitats (e.g., riparian, wetland, limestone, blue oak woodlands) and/or special-status species populations.

Inundation Area It is unfeasible to quantify the number of individual Shasta salamanders that would be lost in the impoundment area. Direct loss of individuals and of limestone habitat from inundation cannot be mitigated. As described above, mitigation lands will be acquired to mitigate for the loss of habitat. Additionally, opportunities for restoration and enhancement of habitat will be explored and defined. Mitigation measure Wild-1 will begin with a 3:1 minimum replacement ratio of acquired lands to impacted lands. This ratio will be applied specific to each habitat type. Additional considerations will be made for other replacement ratios (more or less), depending on habitat quality at a particular site. Emphasis will be placed on lands containing high-value habitats (e.g., riparian, wetland, limestone, blue oak woodlands) and/or special-status species populations.

Under CP1, Wild-1 will mitigate for the loss of 1,195 acres of Shasta salamander habitat in the inundation area and 425 acres in the relocation areas by acquiring a minimum of 4,860 acres of mitigation lands containing comparable habitats. Potential mitigation lands containing comparable Shasta salamander habitat have been identified adjacent to the project. Shasta salamander has been found in both limestone and nonlimestone habitat in this site.

Vegetation Removal and Construction Activities

- To minimize impacts on individuals, preconstruction surveys, in consultation with CDFW and USFS, will be conducted by a qualified biologist before construction activities during the wet season. Individuals will be relocated to suitable limestone habitat in the vicinity of detection.

The avoidance and relocation measures for vegetation removal and construction activities would effectively mitigate impacts caused by those activities. However, the effectiveness of providing compensatory mitigation by acquiring and conserving habitat mitigation lands to mitigate inundation impacts cannot be accurately determined without additional details. Therefore, Impact Wild-1 (CP1) would remain significant and unavoidable.

Mitigation Measure Wild-2 (CP1): Avoid, Relocate, and Acquire Mitigation Lands for Foothill Yellow-Legged Frog and Tailed Frog To avoid or minimize impacts on the foothill yellow-legged frog and tailed frog, the following measures will be implemented.

Inundation Area Individual foothill yellow-legged frog and tailed frogs will not be affected by the inundation caused by the raise of the dam. Animals will be able to swim upstream to suitable habitat.

This mitigation measure is identical to Mitigation Measure Wild-1 (CP1). As described in Wild-1 (CP1), mitigation lands will be acquired to mitigate for the loss of habitat. Additionally, opportunities for restoration and enhancement of habitat will be explored and defined. Mitigation measure Wild-2 will begin with a 3:1 minimum replacement ratio of acquired lands to impacted lands. This ratio will be applied specific to each habitat type. Additional considerations will be made for other replacement ratios (more or less), depending on habitat quality at a particular site. Emphasis will be placed on lands containing high-value habitats (e.g., riparian, wetland, limestone, blue oak woodlands) and/or special-status species populations.

Under CP1, Wild-2 will mitigate for the loss of 35 acres of foothill yellow-legged frog and tailed frog habitat in the inundation area and 1 acre in the relocation areas by acquiring a minimum of 108 acres of mitigation lands containing comparable habitats.

Vegetation Removal and Construction Activities

- To the extent feasible, projects planned in relocation areas will be designed to avoid construction in perennial streams and their associated riparian zones.

- When instream construction activities must occur, a preconstruction survey of the foothill yellow-legged frog and tailed frog adults, larvae, and eggs will be conducted by a qualified biologist before ground-disturbing activities begin in perennial stream and riparian habitat. This survey will be conducted within the construction boundary no more than 1 week before instream or adjacent riparian construction activities begin. If foothill yellow-legged frog or tailed frog adults, larvae, or eggs are detected, the biologist in coordination with CDFW and USFS will relocate them to a suitable stream habitat outside the construction boundary. If frogs are absent, no further surveys will be required.

- If adults are found to use the stream where construction activities are intended to take place, a qualified biologist will relocate all individuals to suitable habitat outside the construction zone daily before instream activities resume.

The avoidance and relocation measures for vegetation removal and construction activities would effectively mitigate impacts caused by those activities. However, the effectiveness of providing compensatory mitigation by acquiring and conserving habitat mitigation lands to mitigate inundation impacts cannot be accurately determined without additional details. Therefore, Impact Wild-2 (CP1) would remain significant and unavoidable.

Mitigation Measure Wild-3 (CP1): Avoid, Relocate, and Acquire Mitigation Lands for Northwestern Pond Turtle To avoid or minimize impacts on the northwestern pond turtle, the following measures will be implemented.

Inundation Area Individual northwestern pond turtles will not be impacted by the inundation caused by the raise of the dam. Lacustrine is suitable habitat for the northwestern pond turtle. The loss of northwestern pond turtle nests in the inundation zone if inundated while eggs are in the nest is unavoidable.

This mitigation measure is identical to Mitigation Measure Wild-1 (CP1). As described in Wild-1 (CP1), mitigation lands will be acquired to mitigate for the loss of habitat. Additionally, opportunities for restoration and enhancement of habitat will be explored and defined. Mitigation measure Wild-3 will begin with a 3:1 minimum replacement ratio of acquired lands to impacted lands. This ratio will be applied specific to each habitat type. Additional considerations will be made for other replacement ratios (more or less), depending on habitat quality at a particular site. Emphasis will be placed on lands containing high-value habitats (e.g., riparian, wetland, limestone, blue oak woodlands) and/or special-status species populations.

Under CP1, Wild-3 will mitigate for the loss of 35 acres of northwestern pond turtle habitat in the inundation area and 1 acre in the relocation areas by acquiring a minimum of 108 acres of mitigation lands containing comparable habitats.

Vegetation Removal and Construction Activities

- To the extent feasible, projects planned in relocation areas will be designed to avoid all suitable aquatic habitat and its associated riparian zone.

- When construction activities are to occur within suitable northwestern pond turtle habitat as defined in Impact Wild-3 (CP1), a qualified biologist will conduct a minimum of one preconstruction survey for northwestern pond turtles and their nests. The survey will be conducted no more than 1 week before construction. If a pond turtle nest is found, the biologist will flag the site and determine whether construction activities can avoid impacting the nest. If the nest cannot be avoided, CDFW and the USFS will be contacted for further direction and construction activities in that location will be halted.

- In the event that a pond turtle is observed within the construction limits, the contractor will temporarily halt construction activities until a qualified biologist has moved the turtle to a safe location within suitable habitat outside of the construction limits.

The avoidance and relocation measures for vegetation removal and construction activities would effectively mitigate impacts caused by those activities. However, the effectiveness of providing compensatory mitigation by acquiring and conserving habitat mitigation lands to mitigate inundation impacts cannot be accurately determined without additional details. Therefore, Impact Wild-3 (CP1) would remain significant and unavoidable.

Mitigation Measure Wild-4 (CP1): Conduct Preconstruction Surveys for the American Peregrine Falcon and Establish Buffers To avoid or minimize impacts on nesting American peregrine falcons, the following measures will be implemented.

Inundation Area Individual American peregrine falcons will not be impacted by the inundation caused by the raise of the dam.

Vegetation Removal and Construction Activities

- To the extent feasible, projects planned in relocation areas will be designed to avoid suitable cliff habitat.

- If vegetation removal or construction occurs outside of the breeding season (August 1 through March 31), no further mitigation will be necessary. If the breeding season cannot be completely avoided, the following measure will be implemented.

- For proposed construction activities during the breeding season (February 1 and July 31) within 0.5 mile of a known American peregrine falcon eyrie or suitable habitat identified in Impact Wild-4 (CP1), a qualified biologist will conduct a protocol-level survey. The survey will be conducted no more than 2 weeks before construction begins. If an active nest is found, a qualified biologist, in consultation with CDFW, will determine the construction-free buffer zone to be established around the nest until the young have fledged. In consultation with CDFW, a plan will be developed to monitor whether construction activity is disturbing the nesting process and to determine when the young have fledged.

Implementation of this mitigation measure would reduce Impact Wild-4 (CP1) to a less-than-significant level.

Mitigation Measure Wild-5 (CP1): Acquire and Preserve Mitigation Lands; Conduct Protocol-Level Surveys for the Bald Eagle and Establish Buffers To avoid or minimize impacts on nesting bald eagles, the following measures will be implemented.

Inundation Area This mitigation measure is identical to Mitigation Measure Wild-1 (CP1). As described in Wild-1 (CP1), mitigation lands will be acquired to mitigate for the loss of habitat. Additionally, opportunities for restoration and enhancement of habitat will be explored and defined. Mitigation measure Wild-5 will begin with a 3:1 minimum replacement ratio of acquired lands to impacted lands. This ratio will be applied specific to each habitat type. Additional considerations will be made for other replacement ratios (more or less), depending on habitat quality at a particular site. Emphasis will be placed on lands containing high-value habitats (e.g., riparian, wetland, limestone, blue oak woodlands) and/or special-status species populations. For bald eagles, emphasis will also be placed on the location of these mitigation lands relative to large water body features to ensure these lands provide potential bald eagle habitat.

Under CP1, Wild-5 will mitigate for the loss of 979 acres of bald eagle habitat in the inundation area and 393 acres in the relocation areas by acquiring a minimum of 4,116 acres of mitigation lands containing comparable habitats. Additional mitigation will be provided by implementing fuels reduction projects within and adjacent to existing bald eagle nest stands at Shasta Lake to help protect those sites from wildfire.

Vegetation Removal and Construction Activities

- For each year of vegetation removal or construction activity, all active bald eagle nests will be located and mapped using the National Bald Eagle Management Guidelines (USFWS 2007).

- If vegetation removal or construction occurs outside of the breeding season (August 2 through December 31), no further mitigation will be necessary. If the breeding season cannot be completely avoided, the following measure will be implemented.

- If vegetation removal is to occur between January 1 and August 1, a 660-foot to 0.5-mile buffer will be established around active nests in consultation with CDFW and USFS. No vegetation removal or construction activity will occur within the established buffer during the limited operating period.

The avoidance and relocation measures for vegetation removal and construction activities and the nest protection measures within the inundation area would effectively mitigate impacts caused by those activities. However, the effectiveness of providing compensatory mitigation by acquiring and conserving habitat mitigation lands to mitigate inundation impacts cannot be accurately determined without additional details. Therefore, Impact Wild-5 (CP1) would remain significant and unavoidable.

Mitigation Measure Wild-6 (CP1): Acquire and Preserve Mitigation Lands for Northern Spotted Owl To avoid or minimize impacts on northern spotted owl dispersal habitat, the following measures will be implemented.

Inundation Area This mitigation measure is identical to Mitigation Measure Wild-1 (CP1). As described in Wild-1 (CP1), mitigation lands will be acquired to mitigate for the loss of habitat. Additionally, opportunities for restoration and enhancement of habitat will be explored and defined. Mitigation measure Wild-6 will begin with a 3:1 minimum replacement ratio of acquired lands to impacted lands. This ratio will be applied specific to each habitat type. Additional considerations will be made for other replacement ratios (more or less), depending on habitat quality at a particular site. Emphasis will be placed on lands containing high-value habitats (e.g., riparian, wetland, limestone, blue oak woodlands) and/or special-status species populations.

Under CP1, Wild-6 will mitigate for the loss of 438 acres of northern spotted owl dispersal habitat in the inundation area and 341 acres in the relocation areas by acquiring a minimum of 2,337 acres of mitigation lands containing comparable habitats.

Providing compensatory mitigation by acquiring and conserving habitat mitigation lands for dispersal habitat will minimize this impact. Implementation of this mitigation measure would reduce Impact Wild-6 (CP1) to a less-than-significant level.

Mitigation Measure Wild-7 (CP1): Conduct a Preconstruction Survey for the Purple Martin and Establish Buffers Purple martins at Shasta Lake nest in flooded snags within the existing reservoir and snags occurring in recently burned areas at nearby upland locations. To avoid or minimize impacts on nesting purple martins, implement the following mitigation measures:

- To the extent feasible, all snags in the Pit Arm will be retained. Vegetation will not be removed from the Pit Arm from Jones Valley north, with exception of Arbuckle Campground, which will provide snag recruitment from trees that will die from inundation.
- If vegetation removal or construction occurs outside of the breeding season (September 1 through March 31), no further mitigation will be necessary. If the breeding season cannot be completely avoided, the following measure will be implemented.
- If proposed vegetation removal and construction activities are to take place on the Pit Arm from April 1 through August 31, a qualified biologist will conduct a protocol-level survey to locate active nests. The survey will be conducted no more than 2 weeks before construction begins. If an active nest is found, a qualified biologist, in consultation with CDFW, will determine a construction-free buffer zone to be established around the nest until the young have fledged. In consultation with CDFW, a plan will be developed to monitor whether construction activity is disturbing the reproductive process and to determine when the young have fledged.

In addition these measures, Reclamation will develop a purple martin management plan that details additional specific actions to minimize impacts in the inundation zone and maintain purple martin habitat in adjacent uplands. At a minimum, the management plan will include the following actions:

- Determine key upland nesting locations and identify vegetation management prescriptions, including prescribed fire and manual/mechanized techniques, which maintain open habitats and snags to preserve purple martin habitat.
- Implement vegetation management that maintains open habitats and snags to preserve purple martin habitat in the key upland locations.
- A minimum of 3 years before project construction and initial (new) inundation, develop an experimental artificial nest box program in upland nesting locations, including monitoring and adaptive management.

Implementation of this mitigation measure will reduce impacts on individual purple martins nesting during the implementation of the project; however, these measures would not protect purple martins actively nesting within the impoundment area when the lake reaches maximum inundation and might not fully mitigate the loss of snags used for nesting. Therefore, Impact Wild-7 (CP1) would remain significant and unavoidable.

Mitigation Measure Wild-8 (CP1): Acquire and Preserve Mitigation Lands; Conduct a Preconstruction Survey for the Willow Flycatcher, Vaux's Swift, Yellow Warbler, and Yellow-Breasted Chat and Establish Buffers To avoid or minimize impacts on nesting willow flycatchers, Vaux's swifts, yellow warblers, and yellow-breasted chats, the following measures will be implemented.

Inundation Area Individuals actively nesting within the impoundment area could be flooded when the lake reaches maximum inundation. These potential losses cannot be mitigated.

This mitigation measure is identical to Mitigation Measure Wild-1 (CP1). As described in Wild-1 (CP1), mitigation lands will be acquired to mitigate for the loss of habitat. Additionally, opportunities for restoration and enhancement of habitat will be explored and defined. Mitigation measure Wild-8 will begin with a 3:1 minimum replacement ratio of acquired lands to impacted lands. This ratio will be applied specific to each habitat type. Additional considerations will be made for other replacement ratios (more or less), depending on habitat quality at a particular site. Emphasis will be placed on lands containing high-value habitats (e.g., riparian, wetland, limestone, blue oak woodlands) and/or special-status species populations.

Under CP1, Wild-8 will mitigate for the loss of 954 acres of Vaux's swift habitat in the inundation area and 390 acres in the relocation areas by acquiring a minimum of 1,344 acres of mitigation lands containing comparable habitats. Also under CP1, Wild-8 will mitigate for the loss of 28 acres of willow flycatcher, yellow warbler, and yellow-breasted chat habitat in the inundation area and 1 acre in the relocation areas by acquiring a minimum of 87 acres of mitigation lands containing comparable habitats.

Vegetation Removal and Construction Activities

- To the extent feasible, projects planned in relocation areas will be designed to avoid riparian habitat.
- To the extent feasible, construction activities will be avoided within riparian habitat and snags suitable for Vaux's swift nesting.
- If vegetation removal or construction occurs outside of the breeding season (September 1 through March 31), no further mitigation will be

necessary. If the breeding season cannot be completely avoided, the following measure will be implemented.

- If proposed vegetation removal and construction activities are to occur within 250 feet of suitable habitat for willow flycatchers, Vaux's swifts, yellow warblers, and yellow-breasted chats between April 1 and August 31, a qualified biologist will conduct a preconstruction survey no more than 2 weeks before construction activities begin. If an active nest is found, a qualified biologist, in consultation with CDFW, will determine a construction-free buffer zone to be established around the nest until the young have fledged. In consultation with CDFW, a plan will be developed to monitor whether construction activity is disturbing the reproductive process and to determine when the young have fledged.

- If willow flycatchers are detected during the preconstruction survey, protocol-level surveys using a current approved protocol will be conducted to locate and monitor active nests.

The avoidance and relocation measures for vegetation removal and construction activities would effectively mitigate impacts caused by those activities; however, these measures would not protect individuals actively nesting within the impoundment area when the lake reaches maximum inundation. Also, the effectiveness of providing compensatory mitigation by acquiring and conserving habitat mitigation lands to mitigate inundation impacts cannot be accurately determined without additional details. Therefore, Impact Wild-8 (CP1) would remain significant and unavoidable.

Mitigation Measure Wild-9 (CP1): Acquire and Preserve Mitigation Lands; Conduct a Preconstruction Survey for the Long-Eared Owl, Northern Goshawk, Cooper's Hawk, Great Blue Heron, and Osprey and Establish Buffers To avoid or minimize impacts to these species, the following measures will be implemented.

Inundation Area This mitigation measure is identical to Mitigation Measure Wild-1 (CP1). As described in Wild-1 (CP1), mitigation lands will be acquired to mitigate for the loss of habitat. Additionally, opportunities for restoration and enhancement of habitat will be explored and defined. Mitigation measure Wild-9 will begin with a 3:1 minimum replacement ratio of acquired lands to impacted lands. This ratio will be applied specific to each habitat type. Additional considerations will be made for other replacement ratios (more or less), depending on habitat quality at a particular site. Emphasis will be placed on lands containing high-value habitats (e.g., riparian, wetland, limestone, blue oak woodlands) and/or special-status species populations.

Under CP1, Wild-9 will mitigate for the loss of 699 acres of long-eared owl and northern goshawk habitat in the inundation area and 327 acres in the relocation areas by acquiring a minimum of 3,078 acres of mitigation lands containing comparable habitats. Also under CP1, Wild-9 will mitigate for the loss of 1,072 acres of Cooper's hawk and great blue heron habitat in the inundation area and 402 acres in the relocation areas by acquiring a minimum of 4,422 acres of mitigation lands containing comparable habitats.

Vegetation Removal and Construction Activities

- To the extent feasible, construction activities will be avoided within riparian habitat.

- If vegetation removal or construction takes place outside of the breeding season (March 31 through September 1), no further mitigation will be necessary. If the breeding season cannot be completely avoided, the following measure will be implemented.

- If proposed vegetation removal and construction activities are to take place within 0.25 mile of suitable habitat for the long-eared owl, northern goshawk, Cooper's hawk, and great blue heron between February 1 and August 31, a qualified biologist will conduct a preconstruction survey no more than 2 weeks before construction activities begin. Protocol-level surveys will be conducted in suitable goshawk habitat.

- If vegetation removal is to occur between February 1 and August 31, a construction-free buffer will be established around active nests in consultation with CDFW and USFS. No vegetation removal or construction activity will occur within the established buffer during the limited operating period.

The avoidance and relocation measures for vegetation removal and construction activities would effectively mitigate impacts caused by those activities. However, the effectiveness of providing compensatory mitigation by acquiring and conserving habitat mitigation lands to mitigate inundation impacts cannot be accurately determined without additional details. Therefore, Impact Wild-9 (CP1) would remain significant and unavoidable.

Mitigation Measure Wild-10 (CP1): Acquire and Preserve Mitigation Lands; Conduct a Preconstruction Survey for the Pacific Fisher and Establish Buffers To avoid or minimize impacts on Pacific fisher natal dens, the following measures will be implemented.

Inundation Area Pacific fisher natal dens within the impoundment area could be flooded when the lake reaches maximum inundation. These potential losses cannot be mitigated. However, female fishers often move young to alternate natal dens if threatened or disturbed.

This mitigation measure is identical to Mitigation Measure Wild-1 (CP1). As described in Wild-1 (CP1), mitigation lands will be acquired to mitigate for the loss of habitat. Additionally, opportunities for restoration and enhancement of habitat will be explored and defined. Mitigation measure Wild-10 will begin with a 3:1 minimum replacement ratio of acquired lands to impacted lands. This ratio will be applied specific to each habitat type. Additional considerations will be made for other replacement ratios (more or less), depending on habitat quality at a particular site. Emphasis will be placed on lands containing high-value habitats (e.g., riparian, wetland, limestone, blue oak woodlands) and/or special-status species populations.

Under CP1, Wild-10 will mitigate for the loss of 749 acres of Pacific fisher habitat in the inundation area and 330 acres in the relocation areas by acquiring a minimum of 3,237 acres of mitigation lands containing comparable habitats. Potential mitigation lands containing comparable habitat and where Pacific fishers are known to occur have been identified adjacent to the project.

Vegetation Removal and Construction Activities

- If vegetation removal or construction occurs outside of the breeding season (February 1 through May 1), no further mitigation will be necessary. If the breeding season cannot be completely avoided, the following measure will be implemented.

- If proposed vegetation removal and construction activities are to occur in suitable habitat for the Pacific fisher between February 1 and May 1, a qualified biologist will conduct a preconstruction survey for potential natal or maternity den trees no more than 2 weeks before construction activities begin. If an active den is found, a qualified biologist, in consultation with USFS, BLM (if on BLM land), and USFWS, will determine a construction-free buffer zone to be established around the den until the mother and young have dispersed. In consultation with USFWS, a plan will be developed to monitor whether construction activity is disturbing the reproductive success and to determine when the young have dispersed.

The avoidance and relocation measures for vegetation removal and construction activities would effectively mitigate impacts caused by those activities. However, the effectiveness of providing compensatory mitigation by acquiring and conserving habitat mitigation lands to mitigate inundation impacts cannot be accurately determined without additional details. Therefore, Impact Wild-10 (CP1) would remain significant and unavoidable.

Mitigation Measure Wild-11 (CP1): Acquire and Preserve Mitigation Lands; Conduct a Preconstruction Survey for Special-Status Bats, American Marten, and Ringtails and Establish Buffers To avoid or minimize impacts on bats, American martens, and ringtails, the following measures will be implemented.

Inundation Area Maternity colonies or natal dens within the impoundment area could be flooded when the lake reaches maximum inundation. These potential losses cannot be mitigated. However, female western red bats, American martens, and ringtails would be expected to move young to alternate locations if threatened or disturbed.

This mitigation measure is identical to Mitigation Measure Wild-1 (CP1). As described in Wild-1 (CP1), mitigation lands will be acquired to mitigate for the loss of habitat. Additionally, opportunities for restoration and enhancement of habitat will be explored and defined. Mitigation measure Wild-11 will begin with a 3:1 minimum replacement ratio of acquired lands to impacted lands. This ratio will be applied specific to each habitat type. Additional considerations will be made for other replacement ratios (more or less), depending on habitat quality at a particular site. Emphasis will be placed on lands containing high-value habitats (e.g., riparian, wetland, limestone, blue oak woodlands) and/or special-status species populations.

Under CP1, Wild-11 will mitigate for the loss of 31 acres of pallid bat, spotted bat, western mastiff bat, Townsend's big-eared bat, Yuma myotis, and fringed myotis habitat in the inundation area and 35 acres in the relocation areas by acquiring a minimum of 198 acres of mitigation lands containing comparable habitats. Also under CP1, Wild-11 will mitigate for the loss of 1,201 acres of western red bat and long-eared myotis habitat in the inundation area and 457 acres in the relocation areas by acquiring a minimum of 4,974 acres of mitigation lands containing comparable habitats.

Under CP1, Wild-11 will mitigate for the loss of 1,201 acres of ringtail habitat in the inundation area and 457 acres in the relocation areas by acquiring a minimum of 1,658 acres of mitigation lands containing comparable habitats. Also under CP1, Wild-11 will mitigate for the loss of 724 acres of American marten habitat in the inundation area and 328 acres in the relocation areas by acquiring a minimum of 3,156 acres of mitigation lands containing comparable habitats.

Vegetation Removal and Construction Activities

- A preconstruction survey conducted by a qualified bat biologist for roosting bats will be conducted before the inundation or removal of any bridges, buildings, known caves, or trees 12 inches or larger in diameter at breast height. If no active roosts are found, then no further action will be warranted. If a maternity roost is present, in consultation with CDFW, a qualified bat biologist will determine the extent of construction-free zones around active nurseries. If either a maternity roost or a hibernacula is present, either of the following measures will be implemented.

To the extent feasible, the project will be redesigned to avoid the loss of the maternity or hibernacula roost.

- If the project cannot be redesigned, removal of the occupied tree or structure should begin before maternity colonies form (i.e., before March 1) or after young are volant (flying) (i.e., after July 31). The established disturbance-free buffer will be observed during the maternity roost season (March 1 through July 31).

- If a nonbreeding bat hibernacula is found in a structure or tree scheduled for removal, the individuals will be safely evicted, under the direction of a qualified bat biologist (as determined by a memorandum of understanding with CDFW), by opening the roosting area to allow air flow through the cavity. Removal of the tree or structure will follow not before the following day (i.e., there should be at least 1 night between initial disturbance for air flow and the demolition). This action will allow bats to leave during dark hours, thus increasing their chance of finding new roosts with a minimum of potential predation during daylight. Trees with roosts that need to be removed should first be disturbed at dusk, just before removal that same evening, to allow bats to escape at night.

- For the American marten and ringtail, if vegetation removal or construction occurs outside of the breeding season (May 2 through January 31), no further mitigation is necessary. If the breeding season cannot be completely avoided, the following measure will be implemented.

- If proposed vegetation removal and construction activities are to occur in suitable habitat for the American marten and ringtail between February 1 and May 1, a qualified biologist will conduct a preconstruction survey for potential natal or maternity den trees no more than 2 weeks before construction activities begin. If an active den is found, a qualified biologist, in consultation with CDFW and USFS, will determine a construction-free buffer zone to be established around the den until the mother and young have dispersed. In consultation with CDFW and USFS, a plan will be developed to monitor whether construction activity is disturbing the reproductive success and to determine when the young have dispersed.

The avoidance and relocation measures for vegetation removal and construction activities would effectively mitigate impacts caused by those activities. However, the loss of some individuals from inundation cannot be mitigated. Also, the effectiveness of providing compensatory mitigation by acquiring and conserving habitat mitigation lands to mitigate inundation impacts cannot be accurately determined without additional details. Therefore, Impact Wild-11 (CP1) would remain significant and unavoidable.

Mitigation Measure Wild-12 (CP1): Avoid Suitable Habitat; Acquire and Preserve Mitigation Lands for Special-Status Terrestrial Mollusks To avoid or minimize impacts on special-status terrestrial mollusks, the following measures will be implemented.

Inundated Area It is infeasible to quantify the loss of individuals in the impoundment area. The loss of individuals and loss of limestone habitat (for Shasta and Wintu sideband snails) cannot be mitigated.

This mitigation measure is identical to Mitigation Measure Wild-1 (CP1). As described in Wild-1 (CP1), mitigation lands will be acquired to mitigate for the loss of habitat. Additionally, opportunities for restoration and enhancement of habitat will be explored and defined. Mitigation measure Wild-12 will begin with a 3:1 minimum replacement ratio of acquired lands to impacted lands. This ratio will be applied specific to each habitat type. Additional considerations will be made for other replacement ratios (more or less), depending on habitat quality at a particular site. Emphasis will be placed on lands containing high-value habitats (e.g., riparian, wetland, limestone, blue oak woodlands) and/or special-status species populations.

Under CP1, Wild-12 will mitigate for the loss of 1,195 acres of Church’s sideband, Oregon shoulderband, and Shasta chaparral habitat in the inundation area and 425 acres in the relocation areas by acquiring a minimum of 4,860 acres of mitigation lands containing comparable habitats. Also under CP1, Wild-12 will mitigate for the loss of 28 acres of Shasta hesperian habitat in the inundation area and 1 acre in the relocation areas by acquiring a minimum of 87 acres of mitigation lands containing comparable habitats.

Under CP1, Wild-12 will mitigate for the loss of 5 acres of Shasta sideband habitat in the inundation area and 1 acre in the relocation areas by acquiring a minimum of 18 acres of mitigation lands containing comparable habitats. Also under CP1, Wild-12 will mitigate for the loss of 1.5 acres of Wintu sideband habitat in the inundation area by acquiring a minimum of 4.5 acres of mitigation lands containing comparable habitats.

Vegetation Removal and Construction Activities

- When feasible, use of heavy equipment and excavation in limestone substrates and riparian or mesic habitats will be avoided.

- Guidelines provided in Management Recommendations for Survey and Manage Terrestrial Mollusks (Burke et al. 1999) will be applied.

The avoidance and relocation measures for vegetation removal and construction activities would effectively mitigate impacts caused by those activities. However, the loss of some individuals from inundation cannot be mitigated. Also, the effectiveness of providing compensatory mitigation by acquiring and conserving habitat mitigation lands to mitigate inundation impacts cannot be accurately determined without additional details. Therefore, Impact Wild-12 (CP1) would remain significant and unavoidable.

Mitigation Measure Wild-13 (CP1): Acquire and Preserve Mitigation Lands for Permanent Loss of General Wildlife Habitat and Western Bumble Bee Habitat Mitigation measure Wild-13 consists of a program to acquire nearby private lands with similar habitat attributes and species composition as those impacted by the SLWRI project. Reclamation has identified several willing private landowners and specific parcels for purchase in the SLWRI project area vicinity. Preliminary investigations of these lands have shown they contain similar and/or additional habitats and special-status species as those impacted by SLWRI. Additionally, the interagency working group identified other private parcels with similar biological resources in the vicinity of the SLWRI project area, some of which have owners willing to discuss purchase agreements.

As discussed during the interagency working group meetings, mitigation measure Wild-13 will begin with a 3:1 minimum replacement ratio of acquired lands to impacted lands. The interagency working group also agreed that additional considerations will be made for other replacement ratios (more or less), depending on habitat quality at a particular site. Emphasis will be placed on lands containing high-value habitats (e.g., riparian, wetland, limestone, blue oak woodlands) and/or special-status species populations.

Under CP1, Wild-13 will mitigate for the loss of 1,227 acres of overall habitats and western bumble bee habitat in the inundation area and 698 acres in the relocation areas by acquiring a minimum of 5,775 acres of mitigation lands containing comparable habitats.

The effectiveness of providing compensatory mitigation by acquiring and conserving habitat mitigation lands to mitigate inundation impacts cannot be accurately determined without additional details. Therefore, Impact Wild-13 (CP1) would remain significant and unavoidable.

Mitigation Measure Wild-14 (CP1): Acquire and Preserve Mitigation Lands and Conduct Preconstruction Surveys for Other Nesting Raptors and Migratory Birds and Establish Buffers To avoid or minimize impacts on nesting raptors and migratory birds, the following measures will be implemented.

Inundation Area Individuals actively nesting within the impoundment area could be flooded when the lake reaches maximum inundation. These potential losses cannot be mitigated.

Vegetation Removal and Construction Activities

- To the extent feasible, construction activities will be avoided within riparian habitat.

- If vegetation removal or construction occurs outside of the breeding season (March 31 through September 1), no further mitigation will be necessary. If the breeding season cannot be completely avoided, the following measure will be implemented.

- If project-related vegetation removal or construction will occur during the breeding season (February 1 through August 31), a qualified biologist will conduct a preconstruction survey for nesting birds. For migratory birds (non-raptors), preconstruction surveys will occur within the construction footprint and 250 feet beyond the construction footprint boundary. Surveys will be conducted no more than 2 weeks before construction. For raptors, preconstruction surveys will occur in suitable raptor nesting habitat within 0.25 mile of the construction footprint boundary. If an active nest is found, a qualified biologist, in consultation with CDFW, will determine a construction-free buffer zone to be established around the nest until the young have fledged. In consultation with CDFW, a plan will be developed to monitor whether construction activity is disturbing the reproductive process and to determine when the young have fledged.

The avoidance and relocation measures for vegetation removal and construction activities would effectively mitigate impacts caused by those activities. However, the loss of some individuals from inundation cannot be mitigated. Also, the effectiveness of providing compensatory mitigation by acquiring and conserving habitat mitigation lands to mitigate inundation impacts cannot be accurately determined without additional details. Therefore, Impact Wild-14 (CP1) would remain significant and unavoidable.

Mitigation Measure Wild-15 (CP1): Acquire and Preserve Mitigation Lands for Permanent Loss of Critical Deer Wintering and Fawning Range

Inundation Area Habitats providing deer wintering and fawning range within the impoundment area would be flooded when the lake reaches maximum inundation. These potential losses cannot be mitigated. Therefore, Impact Wild-15 (CP1) would remain significant and unavoidable.

Mitigation Measure Wild-16 (CP1) Potential impacts and applicable mitigation have yet to be determined for the California red-legged frog. Impacts for each alternative will not be assessed until USFWS has determined whether suitable habitat is present and whether surveys would be required. At that time, the need for mitigation would be determined and appropriate mitigation described, if necessary.

Mitigation Measure Wild-17 (CP1): To Reduce Impacts on Riparian-Associated and Aquatic Special-Status Wildlife in the Primary Study Area, Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan Reclamation will implement Mitigation Measure Bot-7 (CP1), “Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities," described in Chapter 12, "Botanical Resources and Wetlands." Implementation of this mitigation measure would reduce Impact Wild-17 (CP1) to a less-than-significant level.

Mitigation Measure Wild-20 (CP1): To Promote Consistency with Local and Regional Plans with Goals of Promoting Riparian Habitat in the Primary Study Area, Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan
Reclamation will implement Mitigation Measure Bot-7 (CP1), "Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities," described in Chapter 12, "Botanical Resources and Wetlands." Implementation of this mitigation measure would reduce Impact Wild-20 (CP1) to a less-than-significant level.

Mitigation Measure Wild-23 (CP1): To Reduce Impacts on Riparian-Associated and Aquatic Special-Status Wildlife along the Lower Sacramento River Resulting from Modifications of Geomorphic Processes, Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan Reclamation will implement Mitigation Measure Bot-7 (CP1), "Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities," described in Chapter 12, "Botanical Resources and Wetlands." Implementation of this mitigation measure would reduce Impact Wild-23 (CP1) to a less-than-significant level.

Mitigation Measure Wild-26 (CP1): To Promote Consistency with Local and Regional Plans with Goals of Promoting Riparian Habitat along the Lower Sacramento River and in the Delta, Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan Reclamation will implement Mitigation Measure Bot-7 (CP1), "Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities," described in Chapter 12, "Botanical Resources and Wetlands." Implementation of this mitigation measure would reduce Impact Wild-26 (CP1) to a less-than-significant level.

CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability
No mitigation is required for Impacts Wild-18 (CP2), Wild-19 (CP2), Wild-21 (CP2), Wild-22 (CP2), Wild-24 (CP2), Wild-25 (CP2), and Wild-27 (CP2). Mitigation is provided below for the remaining impacts of CP2 on wildlife species.

Mitigation Measure Wild-1 (CP2): Avoid, Relocate, and Acquire Mitigation Lands for Shasta Salamander This mitigation measure is identical to Mitigation Measure Wild-1 (CP1). Implementation of this mitigation measure will reduce impacts on the Shasta salamander; however, because impacts cannot be fully mitigated, Impact Wild-1 (CP2) is considered significant and unavoidable.

Under CP2, Wild-1 will mitigate for the loss of 1,678 acres of Shasta salamander habitat in the inundation area and 425 acres in the relocation areas by acquiring a minimum of 6,309 acres of mitigation lands containing comparable habitats.

Mitigation Measure Wild-2 (CP2): Avoid, Relocate, and Acquire Mitigation Lands for Foothill Yellow-Legged Frog and Tailed Frog This mitigation measure is identical to Mitigation Measure Wild-2 (CP1). Implementation of this mitigation measure will reduce impacts on these species; however, because impacts cannot be fully mitigated, Impact Wild-2 (CP2) is considered significant and unavoidable.

Under CP2, Wild-2 will mitigate for the loss of 47 acres of foothill yellow-legged frog and tailed frog habitat in the inundation area and 1 acre in the relocation areas by acquiring a minimum of 144 acres of mitigation lands containing comparable habitats.

Mitigation Measure Wild-3 (CP2): Avoid, Relocate, and Acquire Mitigation Lands for Northwestern Pond Turtle This mitigation measure is identical to Mitigation Measure Wild-3 (CP1). Implementation of this mitigation measure will reduce impacts on these species; however, because impacts cannot be fully mitigated, Impact Wild-3 (CP2) is considered significant and unavoidable.

Under CP2, Wild-3 will mitigate for the loss of 47 acres of northwestern pond turtle habitat in the inundation area and 1 acre in the relocation areas by acquiring a minimum of 144 acres of mitigation lands containing comparable habitats.

Mitigation Measure Wild-4 (CP2): Conduct Preconstruction Surveys for the American Peregrine Falcon and Establish Buffers This mitigation measure is identical to Mitigation Measure Wild-4 (CP1). Implementation of this mitigation measure will reduce Impact Wild-4 (CP2) to a less-than-significant level.

Mitigation Measure Wild-5 (CP2): Acquire and Preserve Mitigation Lands; Conduct Protocol-Level Surveys for the Bald Eagle and Establish Buffers This mitigation measure is identical to Mitigation Measure Wild-5 (CP1). Implementation of this mitigation measure will reduce impacts on individual bald eagles nesting during the implementation of the project;

however, all nest trees in the inundation zone will be lost. Therefore, Impact Wild-5 (CP2) is considered significant and unavoidable.

Under CP2, Wild-5 will mitigate for the loss of 1,376 acres of bald eagle habitat in the inundation area and 393 acres in the relocation areas by acquiring a minimum of 5,307 acres of mitigation lands containing comparable habitats.

Mitigation Measure Wild-6 (CP2): Acquire and Preserve Mitigation Lands for Northern Spotted Owl This mitigation measure is identical to Mitigation Measure Wild-6 (CP1). Implementation of this mitigation measure will reduce impacts to northern spotted owl dispersal habitat.

Under CP2, Wild-6 will mitigate for the loss of 643 acres of northern spotted owl dispersal habitat in the inundation area and 341 acres in the relocation areas by acquiring a minimum of 2,952 acres of mitigation lands containing comparable habitats.

Mitigation Measure Wild-7 (CP2): Conduct a Preconstruction Survey for the Purple Martin and Establish Buffers This mitigation measure is identical to Mitigation Measure Wild-7 (CP1). Implementation of this mitigation measure will reduce impacts on individual purple martins nesting during the implementation of the project; however, these measures might not fully mitigate the loss of snags used for nesting. Therefore, Impact Wild-7 (CP2) is considered significant and unavoidable.

Mitigation Measure Wild-8 (CP2): Acquire and Preserve Mitigation Lands; Conduct a Preconstruction Survey for the Willow Flycatcher, Vaux's Swift, Yellow Warbler, and Yellow-Breasted Chat and Establish Buffers This mitigation measure is identical to Mitigation Measure Wild-8 (CP1). Implementation of this mitigation measure will reduce impacts on these species; however, because impacts cannot be fully mitigated, Impact Wild-8 (CP2) is considered significant and unavoidable.

Under CP2, Wild-8 will mitigate for the loss of 1,341 acres of Vaux's swift habitat in the inundation area and 390 acres in the relocation areas by acquiring a minimum of 5,193 acres of mitigation lands containing comparable habitats. Also under CP1, Wild-8 will mitigate for the loss of 37 acres of willow flycatcher, yellow warbler, and yellow-breasted chat habitat in the inundation area and 1 acre in the relocation areas by acquiring a minimum of 114 acres of mitigation lands containing comparable habitats.

Mitigation Measure Wild-9 (CP2): Acquire and Preserve Mitigation Lands; Conduct Preconstruction Surveys for the Long-Eared Owl, Northern Goshawk, Cooper's Hawk, Great Blue Heron, and Osprey and Establish Buffers This mitigation measure is identical to Mitigation Measure Wild-9 (CP1). Implementation of this mitigation measure will reduce impacts on these species; however, because impacts cannot be fully mitigated, Impact Wild-9 (CP2) is considered significant and unavoidable.

Under CP2, Wild-9 will mitigate for the loss of 987 acres of long-eared owl and northern goshawk habitat in the inundation area and 327 acres in the relocation areas by acquiring a minimum of 3,942 acres of mitigation lands containing comparable habitats. Also under CP1, Wild-9 will mitigate for the loss of 1,505 acres of Cooper's hawk and great blue heron habitat in the inundation area and 402 acres in the relocation areas by acquiring a minimum of 5,721 acres of mitigation lands containing comparable habitats.

Mitigation Measure Wild-10 (CP2): Acquire and Preserve Mitigation Lands; Conduct Preconstruction Surveys for the Pacific Fisher and Establish Buffers This mitigation measure is identical to Mitigation Measure Wild-10 (CP1). Implementation of this mitigation measure will reduce impacts on these species; however, because impacts cannot be fully mitigated, Impact Wild-10 (CP2) is considered significant and unavoidable.

Under CP2, Wild-10 will mitigate for the loss of 1,057 acres of Pacific fisher habitat in the inundation area and 330 acres in the relocation areas by acquiring a minimum of 4,161 acres of mitigation lands containing comparable habitats. Potential mitigation lands containing comparable habitat and where Pacific fishers are known to occur have been identified adjacent to the project.

Mitigation Measure Wild-11 (CP2): Acquire and Preserve Mitigation Lands; Conduct Preconstruction Surveys for Special-Status Bats, American Marten, and Ringtails and Establish Buffers This mitigation measure is identical to Mitigation Measure Wild-11 (CP1). Implementation of this mitigation measure will reduce impacts on these species; however, because impacts cannot be fully mitigated, Impact Wild-11 (CP2) is considered significant and unavoidable.

Under CP2, Wild-11 will mitigate for the loss of 45 acres of pallid bat, spotted bat, western mastiff bat, Townsend's big-eared bat, Yuma myotis, and fringed myotis habitat in the inundation area and 35 acres in the relocation areas by acquiring a minimum of 240 acres of mitigation lands containing comparable habitats. Also under CP2, Wild-11 will mitigate for the loss of 1,687 acres of western red bat and long-eared myotis habitat in the inundation area and 457 acres in the relocation areas by acquiring a minimum of 6,432 acres of mitigation lands containing comparable habitats.

Under CP2, Wild-11 will mitigate for the loss of 1,687 acres of ringtail habitat in the inundation area and 457 acre in the relocation areas by acquiring a minimum of 6,432 acres of mitigation lands containing comparable habitats. Also under CP2, Wild-11 will mitigate for the loss of 1,022 acres of American marten habitat in the inundation area and 328 acres in the relocation areas by acquiring a minimum of 4,050 acres of mitigation lands containing comparable habitats.

Mitigation Measure Wild-12 (CP2): Avoid Suitable Habitat; Acquire and Preserve Mitigation Lands for Special-Status Terrestrial Mollusks This mitigation measure is identical to Mitigation Measure Wild-12 (CP1). Implementation of this mitigation measure will reduce impacts on special-status terrestrial mollusks; however, because impacts cannot be fully mitigated, Impact Wild-12 (CP2) is considered significant and unavoidable.

Under CP2, Wild-12 will mitigate for the loss of 1,697 acres of Church's sideband, Oregon shoulderband, and Shasta chaparral habitat in the inundation area and 425 acres in the relocation areas by acquiring a minimum of 6,366 acres of mitigation lands containing comparable habitats. Also under CP2, Wild-12 will mitigate for the loss of 37 acres of Shasta hesperian habitat in the inundation area and 1 acre in the relocation areas by acquiring a minimum of 114 acres of mitigation lands containing comparable habitats.

Under CP2, Wild-12 will mitigate for the loss of 7 acres of Shasta sideband habitat in the inundation area and 1 acre in the relocation areas by acquiring a minimum of 24 acres of mitigation lands containing comparable habitats. Also under CP2, Wild-12 will mitigate for the loss of 2 acres of Wintu sideband habitat in the inundation area by acquiring a minimum of 6 acres of mitigation lands containing comparable habitats.

Mitigation Measure Wild-13 (CP2): Acquire and Preserve Mitigation Lands for Permanent Loss of General Wildlife Habitat and Western Bumble Bee Habitat This mitigation measure is identical to Mitigation Measure Wild-13 (CP1). Implementation of this mitigation measure will reduce impacts on these species; however, because impacts cannot be fully mitigated, Impact Wild-13 (CP2) is considered significant and unavoidable.

Under CP2, Wild-13 will mitigate for the loss of 1,725 acres of overall habitats and western bumble bee habitat in the inundation area and 698 acres in the relocation areas by acquiring a minimum of 7,269 acres of mitigation lands containing comparable habitats.

Mitigation Measure Wild-14 (CP2): Acquire and Preserve Mitigation Lands and Conduct Preconstruction Survey for Other Nesting Raptors and Migratory Birds and Establish Buffers This mitigation measure is identical to Mitigation Measure Wild-14 (CP1). Implementation of this mitigation measure will reduce impacts on these species; however, because impacts cannot be fully mitigated, Impact Wild-14 (CP2) is considered significant and unavoidable.

This mitigation measure is identical to Mitigation Measure Wild-1 (CP1). Under CP2, Wild-14 will mitigate for the loss of 1,725 acres of overall habitats and western bumble bee habitat in the inundation area and 698 acres in the relocation areas by acquiring a minimum of 7,239 acres of mitigation lands containing comparable habitats.

Mitigation Measure Wild-15 (CP2): Acquire and Preserve Mitigation Lands for Permanent Loss of Critical Deer Wintering and Fawning Range This mitigation measure is identical to Mitigation Measure Wild-15 (CP1). Implementation of this mitigation measure will reduce impacts on these species; however, because impacts cannot be fully mitigated, Impact Wild-15 (CP2) is considered significant and unavoidable.

This mitigation measure is identical to Mitigation Measure Wild-13 (CP1). Under CP2, Wild-15 will mitigate for the loss of 1,725 acres of overall habitats and western bumble bee habitat in the inundation area and 698 acres in the relocation areas by acquiring a minimum of 7,239 acres of mitigation lands containing comparable habitats.

Mitigation Measure Wild-16 (CP2) Potential impacts and applicable mitigation has yet to be determined for the California red-legged frog. This impact is considered significant and unavoidable.

Mitigation Measure Wild-17 (CP2): To Reduce Impacts on Riparian-Associated and Aquatic Special-Status Wildlife in the Primary Study Area, Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan This mitigation measure is identical to Mitigation Measure Bot-7 (CP2), described in Chapter 12, “Botanical Resources and Wetlands.” Implementation of this mitigation measure would reduce Impact Wild-17 (CP2) to a less-than-significant level.

Mitigation Measure Wild-20 (CP2): To Promote Consistency with Local and Regional Plans with Goals of Promoting Riparian Habitat in the Primary Study Area, Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan This mitigation measure is identical to Mitigation Measure Bot-7 (CP2), described in Chapter 12, “Botanical Resources and Wetlands.” Implementation of this mitigation measure would reduce Impact Wild-20 (CP2) to a less-than-significant level.

Mitigation Measure Wild-23 (CP2): To Reduce Impacts on Riparian-Associated and Aquatic Special-Status Wildlife along the Lower Sacramento River Resulting from Modifications of Geomorphic Processes, Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem

Mitigation and Adaptive Management Plan This mitigation measure is identical to Mitigation Measure Bot-7 (CP2), described in Chapter 12, "Botanical Resources and Wetlands." Implementation of this mitigation measure would reduce Impact Wild-23 (CP2) to a less-than-significant level.

Mitigation Measure Wild-26 (CP2): To Promote Consistency with Local and Regional Plans with Goals of Promoting Riparian Habitat along the Lower Sacramento River and in the Delta, Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan This mitigation measure is identical to Mitigation Measure Bot-7 (CP2), described in Chapter 12, "Botanical Resources and Wetlands." Implementation of this mitigation measure would reduce Impact Wild-26 (CP2) to a less-than-significant level.

CP3 – 18.5-Foot Dam Raise, Agricultural Water Supply Reliability and Anadromous Fish Survival

No mitigation is required for Impacts Wild-18 (CP3), Wild-19 (CP3), Wild-21 (CP3), Wild-22 (CP3), Wild-24 (CP3), Wild-25 (CP3), and Wild-27 (CP3). Mitigation is provided below for the remaining impacts of CP3 on wildlife species.

Mitigation Measure Wild-1 (CP3): Avoid, Relocate, and Acquire Mitigation Lands for Shasta Salamander This mitigation measure is identical to Mitigation Measure Wild-1 (CP1). Implementation of this mitigation measure will reduce impacts on the Shasta salamander; however, because impacts cannot be fully mitigated, Impact Wild-1 (CP3) is considered significant and unavoidable.

Under CP3, Wild-1 will mitigate for the loss of 2,415 acres of Shasta salamander habitat in the inundation area and 425 acres in the relocation areas by acquiring a minimum of 8,520 acres of mitigation lands containing comparable habitats.

Mitigation Measure Wild-2 (CP3): Avoid, Relocate, and Acquire Mitigation Lands for Foothill Yellow-Legged Frog and Tailed Frog This mitigation measure is identical to Mitigation Measure Wild-2 (CP1). Implementation of this mitigation measure will reduce impacts on these species; however, because impacts cannot be fully mitigated, Impact Wild-2 (CP3) is considered significant and unavoidable.

Under CP3, Wild-2 will mitigate for the loss of 80 acres of foothill yellow-legged frog and tailed frog habitat in the inundation area and 1 acre in the relocation areas by acquiring a minimum of 243 acres of mitigation lands containing comparable habitats.

Mitigation Measure Wild-3 (CP3): Avoid, Relocate, and Acquire Mitigation Lands for Northwestern Pond Turtle This mitigation measure is identical to Mitigation Measure Wild-3 (CP1). Implementation of this mitigation measure will reduce impacts on these species; however, because the impacts cannot be fully mitigated, Impact Wild-3 (CP3) is considered significant and unavoidable.

Under CP3, Wild-2 will mitigate for the loss of 80 acres of northwestern pond turtle habitat in the inundation area and 1 acre in the relocation areas by acquiring a minimum of 243 acres of mitigation lands containing comparable habitats.

Mitigation Measure Wild-4 (CP3): Conduct Preconstruction Surveys for the American Peregrine Falcon and Establish Buffers This mitigation measure is identical to Mitigation Measure Wild-4 (CP1). Implementation of this mitigation measure will reduce Impact Wild-4 (CP3) to a less-than-significant level.

Mitigation Measure Wild-5 (CP3): Acquire and Preserve Mitigation Lands; Conduct Protocol-Level Surveys for the Bald Eagle and Establish Buffers This mitigation measure is identical to Mitigation Measure Wild-5 (CP1). Implementation of this mitigation measure will reduce impacts on individual bald eagles nesting during the implementation of the project; however, all nest trees in the inundation zone will be lost. Therefore, Impact Wild-5 (CP3) is considered significant and unavoidable.

Under CP3, Wild-5 will mitigate for the loss of 1,989 acres of bald eagle habitat in the inundation area and 393 acres in the relocation areas by acquiring a minimum of 7,146 acres of mitigation lands containing comparable habitats.

Mitigation Measure Wild-6 (CP3): Acquire and Preserve Mitigation Lands for Northern Spotted Owl This mitigation measure is identical to Mitigation Measure Wild-6 (CP1). Implementation of this mitigation measure will reduce impacts on northern spotted owl dispersal habitat.

Under CP3, Wild-6 will mitigate for the loss of 976 acres of northern spotted owl dispersal habitat in the inundation area and 341 acres in the relocation areas by acquiring a minimum of 3,951 acres of mitigation lands containing comparable habitats.

Mitigation Measure Wild-7 (CP3): Conduct a Preconstruction Survey for the Purple Martin and Establish Buffers This mitigation measure is identical to Mitigation Measure Wild-7 (CP1). Implementation of this mitigation measure will reduce impacts on individual purple martins nesting during the implementation of the project; however, these measures might not fully mitigate for the loss of snags used for nesting; therefore, Impact Wild-7 (CP3) is considered significant and unavoidable.

Mitigation Measure Wild-8 (CP3): Acquire and Preserve Mitigation Lands; Conduct a Preconstruction Survey for the Willow Flycatcher,

Vaux's Swift, Yellow Warbler, and Yellow-Breasted Chat and Establish Buffers This mitigation measure is identical to Mitigation Measure Wild-8 (CP1). Implementation of this mitigation measure will reduce impacts on these species; however, because impacts cannot be fully mitigated, Impact Wild-8 (CP3) is considered significant and unavoidable.

Under CP3, Wild-8 will mitigate for the loss of 1,938 acres of Vaux's swift habitat in the inundation area and 390 acres in the relocation areas by acquiring a minimum of 6,984 acres of mitigation lands containing comparable habitats. Also under CP1, Wild-8 will mitigate for the loss of 58 acres of willow flycatcher, yellow warbler, and yellow-breasted chat habitat in the inundation area and 1 acre in the relocation areas by acquiring a minimum of 177 acres of mitigation lands containing comparable habitats.

Mitigation Measure Wild-9 (CP3): Acquire and Preserve Mitigation Lands; Conduct Preconstruction Surveys for the Long-Eared Owl, Northern Goshawk, Cooper's Hawk, Great Blue Heron, and Osprey and Establish Buffers This mitigation measure is identical to Mitigation Measure Wild-9 (CP1). Implementation of this mitigation measure will reduce impacts on these species; however, because impacts cannot be fully mitigated, Impact Wild-9 (CP3) is considered significant and unavoidable.

Under CP3, Wild-9 will mitigate for the loss of 1,428 acres of long-eared owl and northern goshawk habitat in the inundation area and 327 acres in the relocation areas by acquiring a minimum of 5,265 acres of mitigation lands containing comparable habitats. Also under CP1, Wild-9 will mitigate for the loss of 2,167 acres of Cooper's hawk and great blue heron habitat in the inundation area and 402 acres in the relocation areas by acquiring a minimum of 7,707 acres of mitigation lands containing comparable habitats.

Mitigation Measure Wild-10 (CP3): Acquire and Preserve Mitigation Lands; Conduct Preconstruction Surveys for the Pacific Fisher and Establish Buffers This mitigation measure is identical to Mitigation Measure Wild-10 (CP1). Implementation of this mitigation measure will reduce impacts on these species; however, because impacts cannot be fully mitigated, Impact Wild-10 (CP3) is considered significant and unavoidable.

Under CP2, Wild-10 will mitigate for the loss of 1,533 acres of Pacific fisher habitat in the inundation area and 330 acres in the relocation areas by acquiring a minimum of 5,589 acres of mitigation lands containing comparable habitats. Potential mitigation lands containing comparable habitat and where Pacific fishers are known to occur have been identified adjacent to the project.

Mitigation Measure Wild-11 (CP3): Acquire and Preserve Mitigation Lands; Conduct Preconstruction Surveys for Special-Status Bats, American Marten, and Ringtails and Establish Buffers This mitigation measure is identical to Mitigation Measure Wild-11 (CP1). Implementation of this mitigation measure will reduce impacts on these species; however, because impacts cannot be fully mitigated, Impact Wild-11 (CP3) is considered significant and unavoidable.

Under CP3, Wild-11 will mitigate for the loss of 69 acres of pallid bat, spotted bat, western mastiff bat, Townsend's big-eared bat, Yuma myotis, and fringed myotis habitat in the inundation area and 35 acres in the relocation areas by acquiring a minimum of 312 acres of mitigation lands containing comparable habitats. Also under CP3, Wild-11 will mitigate for the loss of 2,431 acres of western red bat and long-eared myotis habitat in the inundation area and 457 acres in the relocation areas by acquiring a minimum of 8,664 acres of mitigation lands containing comparable habitats.

Under CP3, Wild-11 will mitigate for the loss of 2,431 acres of ringtail habitat in the inundation area and 457 acre in the relocation areas by acquiring a minimum of 8,664 acres of mitigation lands containing comparable habitats. Also under CP3, Wild-11 will mitigate for the loss of 1,482 acres of American marten habitat in the inundation area and 328 acres in the relocation areas by acquiring a minimum of 5,430 acres of mitigation lands containing comparable habitats.

Mitigation Measure Wild-12 (CP3): Avoid Suitable Habitat; Acquire and Preserve Mitigation Lands for Special-Status Terrestrial Mollusks This mitigation measure is identical to Mitigation Measure Wild-12 (CP1). Implementation of this mitigation measure will reduce impacts on special-status terrestrial mollusks; however, because impacts cannot be fully mitigated, Impact Wild-12 (CP3) is considered significant and unavoidable.

Under CP2, Wild-12 will mitigate for the loss of 2,415 acres of Church's sideband, Oregon shoulderband, and Shasta chaparral habitat in the inundation area and 425 acres in the relocation areas by acquiring a minimum of 8,520 acres of mitigation lands containing comparable habitats. Also under CP2, Wild-12 will mitigate for the loss of 58 acres of Shasta hesperian habitat in the inundation area and 1 acre in the relocation areas by acquiring a minimum of 177 acres of mitigation lands containing comparable habitats.

Under CP2, Wild-12 will mitigate for the loss of 11 acres of Shasta sideband habitat in the inundation area and 1 acre in the relocation areas by acquiring a minimum of 36 acres of mitigation lands containing comparable habitats. Also under CP2, Wild-12 will mitigate for the loss of 3 acres of Wintu sideband habitat in the inundation area by acquiring a minimum of 9 acres of mitigation lands containing comparable habitats.

Mitigation Measure Wild-13 (CP3): Acquire and Preserve Mitigation Lands for Permanent Loss of General Wildlife Habitat and Western Bumble Bee Habitat This mitigation measure is identical to Mitigation Measure Wild-13 (CP1). Implementation of this mitigation measure will reduce impacts on these species; however, because the impacts cannot be fully mitigated, Impact Wild-13 (CP3) is considered significant and unavoidable.

Under CP3, Wild-13 will mitigate for the loss of 2,492 acres of overall habitats and western bumble bee habitat in the inundation area and 698 acres in the relocation areas by acquiring a minimum of 9,570 acres of mitigation lands containing comparable habitats.

Mitigation Measure Wild-14 (CP3): Acquire and Preserve Mitigation Lands and Conduct Preconstruction Survey for Other Nesting Raptors and Migratory Birds and Establish Buffers This mitigation measure is identical to Mitigation Measure Wild-14 (CP1). Implementation of this mitigation measure will reduce impacts on these species; however, because impacts cannot be fully mitigated, Impact Wild-14 (CP3) is considered significant and unavoidable.

This mitigation measure is identical to Mitigation Measure Wild-1 (CP1). Under CP3, Wild-14 will mitigate for the loss of 2,492 acres of overall habitats and western bumble bee habitat in the inundation area and 698 acres in the relocation areas by acquiring a minimum of 9,570 acres of mitigation lands containing comparable habitats.

Mitigation Measure Wild-15 (CP3): Acquire and Preserve Mitigation Lands for Permanent Loss of Critical Deer Wintering and Fawning Range This mitigation measure is identical to Mitigation Measure Wild-15 (CP1). Implementation of this mitigation measure will reduce impacts on these species; however, because impacts cannot be fully mitigated, Impact Wild-15 (CP3) is considered significant and unavoidable.

This mitigation measure is identical to Mitigation Measure Wild-13 (CP1). Under CP3, Wild-15 will mitigate for the loss of 2,492 acres of overall habitats and western bumble bee habitat in the inundation area and 698 acres in the relocation areas by acquiring a minimum of 9,570 acres of mitigation lands containing comparable habitats.

Mitigation Measure Wild-16 (CP3): Potential impacts and applicable mitigation has yet to be determined for the California red-legged frog. This impact is considered significant and unavoidable.

Mitigation Measure Wild-17 (CP3): To Reduce Impacts on Riparian-Associated and Aquatic Special-Status Wildlife in the Primary Study Area, Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan This mitigation measure is identical to Mitigation Measure Bot-7 (CP3), described in Chapter 12, "Botanical Resources and Wetlands." Implementation of this mitigation measure would reduce Impact Wild-17 (CP3) to a less-than-significant level.

Mitigation Measure Wild-20 (CP3): To Promote Consistency with Local and Regional Plans with Goals of Promoting Riparian Habitat in the Primary Study Area, Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan This mitigation measure is identical to Mitigation Measure Bot-7 (CP3), described in Chapter 12, "Botanical Resources and Wetlands." Implementation of this mitigation measure would reduce Impact Wild-20 (CP3) to a less-than-significant level.

Mitigation Measure Wild-23 (CP3): To Reduce Impacts on Riparian-Associated and Aquatic Special-Status Wildlife along the Lower Sacramento River Resulting from Modifications of Geomorphic Processes, Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan This mitigation measure is identical to Mitigation Measure Bot-7 (CP3), described in Chapter 12, "Botanical Resources and Wetlands." Implementation of this mitigation measure would reduce Impact Wild-23 (CP3) to a less-than-significant level.

Mitigation Measure Wild-26 (CP3): To Promote Consistency with Local and Regional Plans with Goals of Promoting Riparian Habitat along the Lower Sacramento River and in the Delta, Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan This mitigation measure is identical to Mitigation Measure Bot-7 (CP3), described in Chapter 12, "Botanical Resources and Wetlands." Implementation of this mitigation measure would reduce Impact Wild-26 (CP3) to a less-than-significant level.

CP4 and CP4A – 18.5-Foot Dam Raise, Anadromous Fish Focus with Water Supply Reliability

No mitigation is needed for Impacts Wild-18 (CP4 and CP4A), Wild-19 (CP4 and CP4A), Wild-24 (CP4 and CP4A), Wild-25 (CP4 and CP4A), and Wild-27 (CP4 and CP4A). Mitigation is provided below for the remaining impacts of CP4 or CP4A on wildlife species.

Mitigation Measure Wild-1 (CP4 and CP4A): Avoid, Relocate, and Acquire Mitigation Lands for Shasta Salamander This mitigation measure is identical to Mitigation Measure Wild-1 (CP1). Implementation of this mitigation measure will reduce impacts on the Shasta salamander; however, because impacts cannot be fully mitigated, Impact Wild-1 (CP4 and CP4A) is considered significant and unavoidable.

Mitigation Measure Wild-2 (CP4 and CP4A): Avoid, Relocate, and Acquire Mitigation Lands for Foothill Yellow-Legged Frog and Tailed Frog This mitigation measure is identical to Mitigation Measure Wild-2 (CP1). Implementation of this mitigation measure will reduce impacts on these species; however, because impacts cannot be fully mitigated, Impact Wild-2 (CP4 and CP4A) is considered significant and unavoidable.

Mitigation Measure Wild-3 (CP4 and CP4A): Avoid, Relocate, and Acquire Mitigation Lands for Northwestern Pond Turtle This mitigation measure is identical to Mitigation Measure Wild-3 (CP1). Implementation of this mitigation measure will reduce impacts on these species; however, because impacts cannot be fully mitigated, Impact Wild-3 (CP4 and CP4A) is considered significant and unavoidable.

Mitigation Measure Wild-4 (CP4 and CP4A): Conduct Preconstruction Surveys for the American Peregrine Falcon and Establish Buffers This mitigation measure is identical to Mitigation Measure Wild-4 (CP1). Implementation of this mitigation measure will reduce Impact Wild-4 (CP4 and CP4A) to a less-than- significant level.

Mitigation Measure Wild-5 (CP4 and CP4A): Acquire and Preserve Mitigation Lands; Conduct Protocol-Level Surveys for the Bald Eagle and Establish Buffers This mitigation measure is identical to Mitigation Measure Wild-5 (CP1). Implementation of this mitigation measure will reduce impacts on individual bald eagles nesting during the implementation of the project; however, all nest trees in the inundation zone will be lost. Therefore, Impact Wild-5 (CP4 and CP4A) is considered significant and unavoidable.

Mitigation Measure Wild-6 (CP4 and CP4A): Acquire and Preserve Mitigation Lands for Northern Spotted Owl This mitigation measure is identical to Mitigation Measure Wild-6 (CP1). Implementation of this mitigation measure will reduce impacts on northern spotted owl dispersal habitat.

Mitigation Measure Wild-7 (CP4 and CP4A): Conduct a Preconstruction Survey for the Purple Martin and Establish Buffers This mitigation measure is identical to Mitigation Measure Wild-7 (CP1). Implementation of this mitigation measure will reduce impacts on individual purple martins nesting during the implementation of the project; however, these measures might not fully mitigate the loss of snags used for nesting. Therefore, Impact Wild-7 (CP4 and CP4A) is considered significant and unavoidable.

Mitigation Measure Wild-8 (CP4 and CP4A): Acquire and Preserve Mitigation Lands; Conduct a Preconstruction Survey for the Willow Flycatcher, Vaux's Swift, Yellow Warbler, and Yellow-Breasted Chat and Establish Buffers This mitigation measure is identical to Mitigation Measure Wild-8 (CP1). Implementation of this mitigation measure will reduce impacts on these species; however, because impacts cannot be fully mitigated, Impact Wild-8 (CP4 and CP4A) is considered significant and unavoidable.

Mitigation Measure Wild-9 (CP4 and CP4A): Acquire and Preserve Mitigation Lands; Conduct Preconstruction Surveys for the Long-Eared Owl, Northern Goshawk, Cooper's Hawk, Great Blue Heron, and Osprey and Establish Buffers This mitigation measure is identical to Mitigation

Measure Wild-9 (CP1). Implementation of this mitigation measure will reduce impacts on these species; however, because impacts cannot be fully mitigated, Impact Wild-9 (CP4 and CP4A) is considered significant and unavoidable.

Mitigation Measure Wild-10 (CP4 and CP4A): Acquire and Preserve Mitigation Lands; Conduct Preconstruction Surveys for the Pacific Fisher and Establish Buffers This mitigation measure is identical to Mitigation Measure Wild-10 (CP1). Implementation of this mitigation measure will reduce impacts on these species; however, because impacts cannot be fully mitigated, Impact Wild-10 (CP4 and CP4A) is considered significant and unavoidable.

Mitigation Measure Wild-11 (CP4 and CP4A): Acquire and Preserve Mitigation Lands; Conduct Preconstruction Surveys for Special-Status Bats, American Marten, and Ringtails and Establish Buffers This mitigation measure is identical to Mitigation Measure Wild-11 (CP1). Implementation of this mitigation measure will reduce impacts on these species; however, because impacts cannot be fully mitigated, Impact Wild-11 (CP4 and CP4A) is considered significant and unavoidable.

Mitigation Measure Wild-12 (CP4 and CP4A): Avoid Suitable Habitat; Acquire and Preserve Mitigation Lands for Special-Status Terrestrial Mollusks This mitigation measure is identical to Mitigation Measure Wild-12 (CP1). Implementation of this mitigation measure will reduce impacts on special-status terrestrial mollusks; however, because impacts cannot be fully mitigated, Impact Wild-12 (CP4 and CP4A) is considered significant and unavoidable.

Mitigation Measure Wild-13 (CP4 and CP4A): Acquire and Preserve Mitigation Lands for Permanent Loss of General Wildlife Habitat and Western Bumble Bee Habitat This mitigation measure is identical to Mitigation Measure Wild-13 (CP1). Implementation of this mitigation measure will reduce impacts on these species; however, because impacts cannot be fully mitigated, Impact Wild-13 (CP4 and CP4A) is considered significant and unavoidable.

Mitigation Measure Wild-14 (CP4 and CP4A): Acquire and Preserve Mitigation Lands and Conduct Preconstruction Survey for Other Nesting Raptors and Migratory Birds and Establish Buffers This mitigation measure is identical to Mitigation Measure Wild-14 (CP1). Implementation of this mitigation measure will reduce impacts on these species; however, because impacts cannot be fully mitigated, Impact Wild-14 (CP4 and CP4A) is considered significant and unavoidable.

Mitigation Measure Wild-15 (CP4 and CP4A): Acquire and Preserve Mitigation Lands for Permanent Loss of Critical Deer Wintering and Fawning Range This mitigation measure is identical to Mitigation Measure Wild-15 (CP1). Implementation of this mitigation measure will reduce impacts on these species; however, because impacts cannot be fully mitigated, Impact Wild-15 (CP4 and CP4A) is considered significant and unavoidable.

Mitigation Measure Wild-16 (CP4 and CP4A): Potential impacts and applicable mitigation has yet to be determined for the California red-legged frog. This impact is considered significant and unavoidable.

Mitigation Measure Wild-17 (CP4 and CP4A): To Reduce Impacts on Riparian-Associated and Aquatic Special-Status Wildlife in the Primary Study Area, Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan This mitigation measure is identical to Mitigation Measure Bot-7 (CP4 and CP4A), described in Chapter 12, “Botanical Resources and Wetlands.” Implementation of this mitigation measure would reduce Impact Wild-17 (CP4 and CP4A) to a less-than-significant level.

Mitigation Measure Wild-20 (CP4 and CP4A): To Promote Consistency with Local and Regional Plans with Goals of Promoting Riparian Habitat in the Primary Study Area, Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan This mitigation measure is identical to Mitigation Measure Bot-7 (CP4 and CP4A), described in Chapter 12, “Botanical Resources and Wetlands.” Implementation of this mitigation measure would reduce Impact Wild-20 (CP4 and CP4A) to a less-than-significant level.

Mitigation Measure Wild-21 (CP4 and CP4A): Conduct Preconstruction Surveys for Elderberry Shrubs, Western Pond Turtle, and Nesting Riparian Raptors and Other Nesting Birds; Avoid Removal or Degradation of Elderberry Shrubs; and Avoid Vegetation Removal Near Active Nest Sites To avoid impacts on valley elderberry longhorn beetle, western pond turtle, and nesting raptors, and other nesting birds, Reclamation will implement the following measures at gravel augmentation sites with the potential to affect these species:

Valley Elderberry Longhorn Beetle

- A worker awareness training program for construction personnel will be conducted by a qualified biologist/restoration ecologist before gravel augmentation activities begin. The program will inform all construction personnel about the life history and status of the beetle, the need to avoid damaging the elderberry plants, and the possible penalties for not complying with these requirements. Written documentation of the training will be submitted to USFWS within 30 days of the completion of training.

- Elderberry shrubs shall be protected through establishment of a fenced avoidance area. Fencing will be placed at least 20 feet from the dripline of the shrubs where they occur along any access routes. Signs will be posted along the avoidance area. The signs will state: “This area is the habitat of the valley elderberry longhorn beetle, a threatened species, and must not be disturbed. This species is protected by the Endangered Species Act of 1973, as amended. Violators are subject to prosecution, fines, and imprisonment.” Signs will be readable from a distance of 20 feet. Fencing and signs will be maintained at gravel recruitment sites during construction activities.

- If removal of elderberry shrubs during construction of access routes is unavoidable, Reclamation will consult with USFWS as required under Section 7 of the ESA as appropriate. No project construction will proceed in areas potentially containing valley elderberry longhorn beetle until a BO has been issued by USFWS, and Reclamation has abided by all pertinent conditions in the BO relating to the proposed construction.

- Elderberry shrubs will be mitigated for according to the transplantation guidelines outlined in the Beetle Conservation Guidelines (USFWS 1999). These transplantation guidelines dictate the necessary timing and details of the transplanting. At the discretion of USFWS, shrubs that are unlikely to survive transplantation because of poor condition or location, or a plant that would be extremely difficult to move because of access problems, may be exempted from transplantation. In cases where transplantation is not possible, compensation ratios would be increased to offset the additional habitat loss.

- Relocation of existing elderberry shrubs and planting of new elderberry seedlings will be implemented on a no-net-loss basis. Compensatory mitigation for elderberry shrubs that would be removed from their current locations will be developed in consultation with USFWS during the Section 7 consultation process. Compensatory mitigation may include planting replacement elderberry seedlings or cuttings and associated native plants or purchasing credits at an approved mitigation bank, or a combination thereof. Relocated and replacement shrubs and associated native plantings will be placed in conservation areas providing a minimum of 1,800 square feet per transplanted shrub.

- No insecticides, herbicides, fertilizers, or other chemicals that might harm the beetle or its host plant will be used within 100 feet of elderberry shrubs. Roadways and disturbed areas within 100 feet of elderberry shrubs will be watered at least twice a day and as needed to minimize dust emissions.

Western Pond Turtle

- When construction activities are to occur within suitable western pond turtle habitat as defined in Impact Wild-3 (CP1), a qualified biologist will conduct a minimum of one preconstruction survey for western pond turtles and their nests. The survey will be conducted no more than 1 week before construction. If a pond turtle nest is found, the biologist will flag the site and determine whether construction activities can avoid impacting the nest. If the nest cannot be avoided, CDFW will be contacted for further direction and construction activities in that location will be halted.

- In the event that a pond turtle is observed within the construction limits, the contractor will temporarily halt construction activities until a qualified biologist has moved the turtle to a safe location within suitable habitat outside of the construction limits.

- When feasible, work areas will be surrounded by exclusion fencing consisting of silt fence securely staked into the ground, with the bottom edge buried at least 6 inches to prevent turtles from accessing the work sites from upland locations.

Birds

- For each year of vegetation removal for gravel augmentation activity, all active bald eagle nests will be located and mapped using the National Bald Eagle Management Guidelines (USFWS 2007).

- In consultation with CDFW and USFS, a 660-foot to 0.5-mile buffer will be established around active nests. Vegetation will be retained and no construction activities will occur within this buffer.

- If proposed vegetation removal would occur between April 1 and August 31, a qualified biologist will conduct a preconstruction survey for nesting special-status birds no more than 2 weeks before construction activities begin. If an active nest is found, a qualified biologist, in consultation with CDFW, will determine a construction-free buffer zone to be established around the nest until the young have fledged. In consultation with CDFW, a plan will be developed to monitor whether construction activity is disturbing the reproductive process and to determine when the young have fledged.

Implementation of this mitigation measure would reduce Impact Wild-21 (CP4 and CP4A) to a less-than-significant level.

Mitigation Measure Wild-22 (CP4 and CP4A): Implement Mitigation Measure Wild-21: Conduct Preconstruction Surveys for Elderberry Shrubs, Western Pond Turtle, and Nesting Riparian Raptors and Other Nesting Birds; Avoid Removal or Degradation of Elderberry Shrubs; and Avoid Vegetation Removal Near Active Nest Sites To avoid impacts on valley elderberry longhorn beetle, western pond turtle, nesting raptors, and other nesting birds, Reclamation will implement the following measures as part of the gravel augmentation activities project at augmentation sites with the potential to affect these species:

Valley Elderberry Longhorn Beetle This mitigation measure is identical to Mitigation Measure Wild-21 (CP4 and CP4A) for valley elderberry longhorn beetle, except that the following additional measures will be implemented:

- Before implementation of any vegetation improvements or other activities associated with gravel augmentation, including constructing access routes, a survey will be conducted to identify and map all elderberry shrubs.
- New roads, trails, and staging areas will be constructed a minimum of 100 feet from elderberry shrubs.
- Removal and disturbance of elderberry shrubs will be avoided, to the extent feasible.

Western Pond Turtle This mitigation measure is identical to Mitigation Measure Wild-21 (CP4 and CP4A) for western pond turtles.

Birds This mitigation measure is identical to Mitigation Measure Wild-21 (CP4 and CP4A) for birds.

Implementation of this mitigation measure would reduce Impact Wild-22 (CP4 and CP4A) to a less-than-significant level.

Mitigation Measure Wild-23 (CP4 and CP4A): To Reduce Impacts on Riparian-Associated and Aquatic Special-Status Wildlife along the Lower Sacramento River Resulting from Modifications of Geomorphic Processes, Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan This mitigation measure is identical to Mitigation Measure Bot-7 (CP4 and CP4A), described in Chapter 12, “Botanical Resources and Wetlands.” Implementation of this mitigation measure would reduce Impact Wild-23 (CP4 and CP4A) to a less-than-significant level.

Mitigation Measure Wild-26 (CP4 and CP4A): To Promote Consistency with Local and Regional Plans with Goals of Promoting Riparian Habitat along the Lower Sacramento River and in the Delta, Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan This mitigation measure is identical to Mitigation Measure Bot-7 (CP4 and CP4A), described in Chapter 12, “Botanical Resources and Wetlands.” Implementation of this mitigation measure would reduce Impact Wild-26 (CP4 and CP4A) to a less-than-significant level.

CP5 – 18.5-Foot Dam Raise, Combination Plan

No mitigation is required for Impacts Wild-18 (CP5), Wild-19 (CP5), Wild-24 (CP5), Wild-25 (CP5), and Wild-27 (CP5). Mitigation is provided below for the remaining impacts of CP5 on wildlife species.

Mitigation Measure Wild-1 (CP5): Avoid, Relocate, and Acquire Mitigation Lands for Shasta Salamander This mitigation measure is identical to Mitigation Measure Wild-1 (CP1). Implementation of this mitigation measure will reduce impacts on the Shasta salamander; however, because impacts cannot be fully mitigated, Impact Wild-1 (CP5) is considered significant and unavoidable.

Mitigation Measure Wild-2 (CP5): Avoid, Relocate, and Acquire Mitigation Lands for Foothill Yellow-Legged Frog and Tailed Frog This mitigation measure is identical to Mitigation Measure Wild-2 (CP1). Implementation of this mitigation measure will reduce impacts on these species; however, because impacts cannot be fully mitigated, Impact Wild-2 (CP5) is considered significant and unavoidable.

Mitigation Measure Wild-3 (CP5): Avoid, Relocate, and Acquire Mitigation Lands for Northwestern Pond Turtle This mitigation measure is identical to Mitigation Measure Wild-3 (CP1). Implementation of this mitigation measure will reduce impacts on these species; however, because impacts cannot be fully mitigated, Impact Wild-3 (CP5) is considered significant and unavoidable.

Mitigation Measure Wild-4 (CP5): Conduct Preconstruction Surveys for the American Peregrine Falcon and Establish Buffers This mitigation measure is identical to Mitigation Measure Wild-4 (CP1). Implementation of this mitigation measure will reduce Impact Wild-4 (CP5) to a less-than-significant level.

Mitigation Measure Wild-5 (CP5): Acquire and Preserve Mitigation Lands; Conduct Protocol-Level Surveys for the Bald Eagle and Establish Buffers This mitigation measure is identical to Mitigation Measure Wild-5 (CP1). Implementation of this mitigation measure will reduce impacts on individual bald eagles nesting during the implementation of the project; however, all nest trees in the inundation zone will be lost. Therefore, Impact Wild-5 (CP5) is considered significant and unavoidable.

Mitigation Measure Wild-6 (CP5): Acquire and Preserve Mitigation Lands for Northern Spotted Owl This mitigation measure is identical to Mitigation Measure Wild-6 (CP1). Implementation of this mitigation measure will reduce impacts on northern spotted owl dispersal habitat.

Mitigation Measure Wild-7 (CP5): Conduct a Preconstruction Survey for the Purple Martin and Establish Buffers This mitigation measure is identical to Mitigation Measure Wild-7 (CP1). Implementation of this mitigation measure will reduce impacts on individual purple martins nesting during the implementation of the project; however, these measures might not fully mitigate the loss of snags used for nesting. Therefore, Impact Wild-7 (CP5) is considered significant and unavoidable.

Mitigation Measure Wild-8 (CP5): Acquire and Preserve Mitigation Lands; Conduct a Preconstruction Survey for the Willow Flycatcher, Vaux's Swift, Yellow Warbler, and Yellow-Breasted Chat and Establish Buffers This mitigation measure is identical to Mitigation Measure Wild-8 (CP1). Implementation of this mitigation measure will reduce impacts on these species; however, because impacts cannot be fully mitigated, Impact Wild-8 (CP5) is considered significant and unavoidable.

Mitigation Measure Wild-9 (CP5): Acquire and Preserve Mitigation Lands; Conduct Preconstruction Surveys for the Long-Eared Owl, Northern Goshawk, Cooper's Hawk, Great Blue Heron, and Osprey and Establish Buffers This mitigation measure is identical to Mitigation Measure Wild-9 (CP1). Implementation of this mitigation measure will reduce impacts on these species; however, because impacts cannot be fully mitigated, Impact Wild-9 (CP5) is considered significant and unavoidable.

Mitigation Measure Wild-10 (CP5): Acquire and Preserve Mitigation Lands; Conduct Preconstruction Surveys for the Pacific Fisher and Establish Buffers This mitigation measure is identical to Mitigation Measure Wild-10 (CP1). Implementation of this mitigation measure will reduce impacts on these species; however, because impacts cannot be fully mitigated, Impact Wild-10 (CP5) is considered significant and unavoidable.

Mitigation Measure Wild-11 (CP5): Acquire and Preserve Mitigation Lands; Conduct Preconstruction Surveys for Special-Status Bats, American Marten, and Ringtails and Establish Buffers This mitigation measure is identical to Mitigation Measure Wild-11 (CP1). Implementation of this mitigation measure will reduce impacts on these species; however, because impacts cannot be fully mitigated, Impact Wild-11 (CP5) is considered significant and unavoidable.

Mitigation Measure Wild-12 (CP5): Avoid Suitable Habitat; Acquire and Preserve Mitigation Lands for Special-Status Terrestrial Mollusks This mitigation measure is identical to Mitigation Measure Wild-12 (CP1). Implementation of this mitigation measure will reduce impacts on special-status terrestrial mollusks; however, because impacts cannot be fully mitigated, Impact Wild-12 (CP5) is considered significant and unavoidable.

Mitigation Measure Wild-13 (CP5): Acquire and Preserve Mitigation Lands for Permanent Loss of General Wildlife Habitat and Western Bumble Bee Habitat This mitigation measure is identical to Mitigation

Measure Wild-13 (CP1). Implementation of this mitigation measure will reduce impacts on these species; however, because impacts cannot be fully mitigated, Impact Wild-13 (CP5) is considered significant and unavoidable.

Mitigation Measure Wild-14 (CP5): Acquire and Preserve Mitigation Lands and Conduct Preconstruction Survey for Other Nesting Raptors and Migratory Birds and Establish Buffers This mitigation measure is identical to Mitigation Measure Wild-14 (CP1). Implementation of this mitigation measure will reduce impacts on these species; however, because impacts cannot be fully mitigated, Impact Wild-14 (CP5) is considered significant and unavoidable.

Mitigation Measure Wild-15 (CP5): Acquire and Preserve Mitigation Lands for Permanent Loss of Critical Deer Wintering and Fawning Range This mitigation measure is identical to Mitigation Measure Wild-15 (CP1). Implementation of this mitigation measure will reduce impacts on these species; however, because impacts cannot be fully mitigated, Impact Wild-15 (CP5) is considered significant and unavoidable.

Mitigation Measure Wild-16 (CP5) Potential impacts and applicable mitigation has yet to be determined for the California red-legged frog. This impact is considered significant and unavoidable.

Mitigation Measure Wild-17 (CP5): To Reduce Impacts on Riparian-Associated and Aquatic Special-Status Wildlife in the Primary Study Area, Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan This mitigation measure is identical to Mitigation Measure Bot-7 (CP5), described in Chapter 12, "Botanical Resources and Wetlands." Implementation of this mitigation measure would reduce Impact Wild-17 (CP5) to a less-than-significant level.

Mitigation Measure Wild-20 (CP5): To Promote Consistency with Local and Regional Plans with Goals of Promoting Riparian Habitat in the Primary Study Area, Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan This mitigation measure is identical to Mitigation Measure Bot-7 (CP5), described in Chapter 12, "Botanical Resources and Wetlands." Implementation of this mitigation measure would reduce Impact Wild-20 (CP5) to a less-than-significant level.

Mitigation Measure Wild-21 (CP5): Conduct Preconstruction Surveys for Elderberry Shrubs, Western Pond Turtle, and Nesting Riparian Raptors and Other Nesting Birds; Avoid Removal or Degradation of Elderberry Shrubs; and Avoid Vegetation Removal Near Active Nest Sites This mitigation measure is identical to Mitigation Measure Wild-21 (CP4 and CP4A). Implementation of this mitigation measure would reduce Impact Wild-21 (CP5) to a less-than-significant level.

Mitigation Measure Wild-22 (CP5): Implement Mitigation Measure Wild-21: Conduct Preconstruction Surveys for Elderberry Shrubs, Western Pond Turtle, and Nesting Riparian Raptors and Other Nesting Birds; Avoid Removal or Degradation of Elderberry Shrubs; and Avoid Vegetation Removal Near Active Nest Sites This mitigation measure is identical to Mitigation Measure Wild-22 (CP4 and CP4A). Implementation of this mitigation measure would reduce Impact Wild-22 (CP5) to a less-than-significant level.

Mitigation Measure Wild-23 (CP5): To Reduce Impacts on Riparian-Associated and Aquatic Special-Status Wildlife along the Lower Sacramento River Resulting from Modifications of Geomorphic Processes, Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan This mitigation measure is identical to Mitigation Measure Bot-7 (CP5), described in Chapter 12, “Botanical Resources and Wetlands.” Implementation of this mitigation measure would reduce Impact Wild-23 (CP5) to a less-than-significant level.

Mitigation Measure Wild-26 (CP5): To Promote Consistency with Local and Regional Plans with Goals of Promoting Riparian Habitat along the Lower Sacramento River and in the Delta, Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan This mitigation measure is identical to Mitigation Measure Bot-7 (CP5), described in Chapter 12, “Botanical Resources and Wetlands.” Implementation of this mitigation measure would reduce Impact Wild-26 (CP5) to a less-than-significant level.

13.3.6 Cumulative Effects

Chapter 3, “Considerations for Describing the Affected Environment and Environmental Consequences,” discusses overall cumulative impacts methodology related to the action alternatives, including the relationship to the CALFED Bay-Delta Program Programmatic EIS/EIR cumulative impacts analysis, qualitative and quantitative assessment, past and future actions in the study area, and significance criteria. Table 3-1, “Present and Reasonably Foreseeable Future Actions Included in the Analysis of Cumulative Impacts, by Resource Area,” in Chapter 3, lists the present and reasonably foreseeable future projects considered quantitatively and qualitatively within the cumulative impacts analysis. This cumulative impacts analysis accounts for potential project impacts combined with the impacts of existing facilities, conditions, land uses, and reasonably foreseeable actions expected to occur in the study area on a qualitative and quantitative level. None of the projects listed in Table 3-1 under Quantitative Analysis would have impacts on wildlife resources in the primary study area, nor would they have overlapping cumulative effects on wildlife resources with any of the action alternatives. Therefore, the following analysis is based on the programs and projects listed in the Qualitative Analysis section of Table 3-1. Projects listed in Table 3-1 that may have cumulative effects in the primary and extended study area include, but are not limited to, the CALFED Ecosystem Restoration Program, Bay-Delta Conservation Plan, Sacramento River Conservation Area Forum Program, Central Valley Flood Protection Plan, PG&E and DWR Hydropower Relicensing Programs, Antlers Bridge Replacement, Moody Flats Quarry, and the Mountain Gate at Shasta Mixed Use Area Plan.

A large number of past actions have occurred in the study area. These past actions have substantially degraded wildlife resources in the primary and extended study areas. This degradation is in part indicated by the number of species that have been listed as threatened or endangered under the CESA and ESA, or considered species of special concern by CDFW.

Past actions have caused these effects by converting habitat to developed or agricultural land uses, altering biotic interactions or physical processes, and damaging or causing mortality from human activities (e.g., vegetation removal during agricultural, road, dam, levee, or utility maintenance).

Flood control and water supply projects have also altered physical processes within the study area's remaining natural vegetation. Levees have isolated large areas of floodplain from rivers and streams throughout the study area, reducing (or entirely eliminating) the frequency of inundation and sediment scour and deposition and altering the extent and quality of riparian habitats. By reducing the magnitude and frequency of winter and spring peak flows and increasing the volume of summer and fall flows, water storage projects have altered the riparian habitats that were not isolated from rivers by levees. In particular, the operation of Shasta Dam (beginning in 1945) and the other major reservoirs of the CVP and SWP has strongly affected aquatic and riparian communities along the Sacramento River, other Central Valley rivers, and in the Delta (Fremier 2003, TNC et al. 2008).

The effects of climate change on operations at Shasta Lake could potentially affect wildlife both at the lake and downstream. As described in the Climate Change Modeling Appendix, climate change could result in higher reservoir releases in the future because of an increase in winter and early-spring inflow into the lake from high-intensity storm events. The change in reservoir releases could be necessary to manage for flood events resulting from these potentially larger storms. The potential increase in releases from the reservoir could lead to long-term changes in flooding frequency, downstream habitat for wildlife, and water temperatures which could affect habitat along the Sacramento River and in the Delta. Climate change is also expected to result in changes to conditions for agricultural land and forest land, which are both habitat types. See Chapter 10, "Agriculture and Important Farmland," for a detailed discussion of effects on these habitat types.

Shasta Lake and Vicinity

The construction of Shasta Dam and the subsequent flooding of the area now known as Shasta Lake affected botanical and wildlife resources endemic to the region. For example, based on population locations, Shasta snow-wreath populations may have connected at the confluence of the Pit River, Squaw Creek, McCloud River, and Sacramento River before inundation. The creation of Shasta Lake fragmented this species habitat and populations. As a result, these populations are more vulnerable to extirpation.

As described in Section 13.3, without mitigation, CP1 through CP5 could cause potentially significant effects on wildlife habitats and special-status wildlife species in the primary and extended study areas. These effects could be caused by project construction activities; increased elevations of the water surface of Shasta Lake; and alteration of the flow regime of the Sacramento River and associated geomorphic processes, and thus of riparian vegetation. Although causing similar effects, CP1 through CP5 differ in the magnitude of their effects. At Shasta Lake and its vicinity, these potential adverse effects would be similar for all alternatives, but differ with the height of the dam raise: the effects of CP2 would be greater than CP1, the same as CP4A, and less than CP3 through CP5 (which would be identical). Along the upper Sacramento River and in the extended study area, potential adverse effects would be the result of altered flow regimes and would differ with both the height of the dam raise and operation of the dam: the effects of CP2 would be greater than CP1 and CP4 (which would be identical), the same as CP4A, and less than CP3 and CP5 (which also would have identical effects).

At Shasta Lake and vicinity, CP1 through CP5 would cause the take and loss of habitat for numerous species, including Shasta salamander, foothill yellow-legged frog, tailed frog, Northwestern pond turtle, American peregrine falcon, bald eagle, northern spotted owl, purple martin, Vaux's swift, yellow warbler, yellow-breasted chat, long-eared owl, northern goshawk, Cooper's hawk, osprey, Pacific fisher, and other special-status species. The wildlife mitigation measures described in Section 13.3.5 would reduce impacts on wildlife resources, although the adverse effects of CP1 through CP5 caused by construction activities and inundation would not be eliminated. Because the overall effect of past actions on these species has been cumulatively significant, and the likely additional effects of reasonably foreseeable future actions on wildlife habitat at Shasta Lake and in its vicinity, the adverse effects under CP1 through CP5 would cause a cumulatively considerable incremental contribution to the significant cumulative impact on wildlife.

Upper Sacramento River and Extended Study Area

CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability As described in Chapter 2, "Alternatives," without mitigation, CP1 could cause potentially significant effects on vegetation, wildlife habitats, and special-status wildlife species in the primary and extended study areas. These effects could be caused by alteration of the flow regime of the Sacramento River and associated geomorphic processes in the primary study area or the extended study area, or both. Given major past alterations to vegetation and wildlife habitat along the Sacramento River, the adverse effects from CP1 would be a cumulatively considerable incremental contribution to significant cumulative effects on vegetation, wildlife habitats, and special-status wildlife species. With implementation of Mitigation Measure Bot-7, "Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities" (see Chapter 12, "Botanical Resources and Wetlands"), adverse effects from CP1 would no longer result in a cumulatively considerable incremental contribution to significant cumulative effects on these resources.

As stated previously, effects of climate change on operations at Shasta Lake could include a higher frequency of high-flow events, potentially resulting in changes to downstream habitats. Potentially significant effects on vegetation, wildlife habitats, and special-status wildlife species that would occur with implementation of CP1 could contribute to potentially significant effects of climate change on habitat acreages and distribution. However, with implementation of the mitigation measures listed above to reduce project-related impacts of CP1, CP1 would not make a cumulatively considerable incremental contribution to a significant cumulative effect.

CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability The cumulative effects of CP2 would be similar to those of CP1, but greater in magnitude. Given major past alterations to vegetation and wildlife habitat along the Sacramento River, the contributing adverse effects from CP2 would be a cumulatively considerable incremental contribution to significant cumulative effects on vegetation, wildlife habitats, and special-status wildlife species. With implementation of Mitigation Measure Bot-7, "Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities" (see Chapter 12, "Botanical Resources and Wetlands"), adverse effects from CP2 would no longer result in a cumulatively considerable incremental contribution to significant cumulative effects on these resources.

As stated previously, effects of climate change on operations at Shasta Lake could include a higher frequency of high-flow events, potentially resulting in changes to downstream habitats. Potentially significant effects on vegetation, wildlife habitats, and special-status wildlife species that would occur with implementation of CP2 could contribute to potentially significant effects of climate change on habitat acreages and distribution. However, with implementation of the mitigation measures listed above to reduce project-related impacts of CP2, CP2 would not make a cumulatively considerable incremental contribution to a significant cumulative effect.

CP3 – 18.5-Foot Dam Raise, Agricultural Water Supply Reliability and Anadromous Fish Survival The cumulative effects of CP3 would be similar to those of CP1, but greater in magnitude. Given major past alterations to vegetation and wildlife habitat along the Sacramento River, the contributing adverse effects from CP3 would be a cumulatively considerable incremental contribution to significant cumulative effects on vegetation, wildlife habitats, and special-status wildlife species. With implementation of Mitigation Measure Bot-7, "Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities" (see Chapter 12, "Botanical Resources and Wetlands"), adverse effects from CP3 would no longer result in a cumulatively considerable incremental contribution to significant cumulative effects on these resources.

As stated previously, effects of climate change on operations at Shasta Lake could include a higher frequency of high-flow events, potentially resulting in changes to downstream habitats. Potentially significant effects on vegetation, wildlife habitats, and special-status wildlife species that would occur with implementation of CP3 could contribute to potentially significant effects of climate change on habitat acreages and distribution. However, with implementation of the mitigation measures listed above to reduce project-related impacts of CP3, CP3 would not make a cumulatively considerable incremental contribution to a significant cumulative effect.

CP4 and CP4A – 18.5-Foot Dam Raise, Anadromous Fish Focus with Water Supply Reliability The cumulative effects of CP4 or CP4A would be similar to those of CP1, but greater in magnitude. Given major past alterations to vegetation and wildlife habitat along the Sacramento River, the contributing adverse effects from CP4 or CP4A would be a cumulatively considerable incremental contribution to significant cumulative effects on vegetation, wildlife habitats, and special-status wildlife species. With implementation of Mitigation Measure Bot-7, "Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities" (see Chapter 12, "Botanical Resources and Wetlands"), adverse effects from CP4 or CP4A would no longer result in a cumulatively considerable incremental contribution to significant cumulative effects on these resources.

As stated previously, effects of climate change on operations at Shasta Lake could include a higher frequency of high-flow events, potentially resulting in changes to downstream habitats. Potentially significant effects on vegetation, wildlife habitats, and special-status wildlife species that would occur with implementation of CP4 or CP4A could contribute to potentially significant effects of climate change on habitat acreages and distribution. However, with implementation of the mitigation measures listed above to reduce project-related impacts of CP4 or CP4A, there would not be a cumulatively considerable incremental contribution to a potentially significant cumulative effect.

CP5 – 18.5-Foot Dam Raise, Combination Plan The cumulative effects of CP5 would be similar to those of CP1, but greater in magnitude. Given major past alterations to vegetation and wildlife habitat along the Sacramento River, the contributing adverse effects from CP5 would be a cumulatively considerable incremental contribution to significant cumulative effects on vegetation, wildlife habitats, and special-status wildlife species. With implementation of Mitigation Measure Bot-7, “Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities” (see Chapter 12, “Botanical Resources and Wetlands”), adverse effects from CP5 would no longer result in a cumulatively considerable incremental contribution to significant cumulative effects on these resources.

As stated previously, effects of climate change on operations at Shasta Lake could include a higher frequency of high-flow events, potentially resulting in changes to downstream habitats. Potentially significant effects on vegetation, wildlife habitats, and special-status wildlife species that would occur with implementation of CP5 could contribute to potentially significant effects of climate change on habitat acreages and distribution. However, with implementation of the mitigation measures listed above to reduce project-related impacts of CP5, CP5 would not make a cumulatively considerable incremental contribution to a significant cumulative effect.

Chapter 14
Cultural Resources

This chapter describes the affected environment and environmental consequences related to cultural resources for the dam and reservoir modifications proposed under SLWRI action alternatives. More detailed discussion of cultural resources is presented in *Cultural Resources Alternatives Assessment for the Shasta Lake Water Resources Investigation, Shasta and Tehama Counties, California* (Byrd et al. 2008) and *Native American Tribal Coordination, Shasta Lake Water Resources Investigation, California* (Nilsson et al. 2008), which were prepared for the project. These Technical Reports will not be publicly distributed because they contain confidential information on the locations of cultural resources.

14.1 Affected Environment

For the cultural resources assessment, studies were limited to the Shasta Lake and vicinity (77,088 acres) and the upper Sacramento River (16,113 acres), for a total of 93,201 acres (Byrd et al. 2008). Project impacts to cultural resources are not expected to extend beyond this primary study area. Shasta Lake and vicinity includes the existing reservoir, the maximum inundation area, and a 0.25-mile buffer. The 0.25-mile buffer encompasses the area around the reservoir where infrastructure would need to be relocated (recreation facilities, roads, utilities, trails, etc.). The majority of lands in the reservoir area are under Federal ownership and management responsibilities, and a detailed discussion of this topic can be found in Chapter 17. The upper Sacramento River is defined by the 100-year floodplain from Keswick Dam, north of Redding, southward to the Red Bluff Pumping Plant.

To evaluate the potential effects that the proposed undertaking may have on cultural resources within the 93,201-acre study area, archival and records searches were conducted. Information concerning potential Native American concerns within the study area was gathered from historic and ethnographic literature and from initial discussions with tribes and Native American individuals. The results of these efforts are summarized below, following a brief discussion of the regional context.

14.1.1 Regional Setting

This section provides a regional framework of the study area including sections on the prehistoric, ethnohistorical, and historical context of the study area. Because of the regional nature of cultural resources, the Shasta Lake vicinity and upper Sacramento River area are discussed together.

Prehistoric Context

The following presentation provides a temporally organized discussion of the archaeological record. There is a long history of archaeological investigations in the upper Sacramento Valley region, although the early investigations were sporadic rather than sustained research programs. Notably, a great deal of fieldwork has been carried out around Shasta Lake, largely on USFS lands. Radiocarbon dating and temporally diagnostic artifacts have been used to create a framework for understanding the age of cultural resources in the area as well as changes through time. This framework provides baseline information on how cultural resources can contribute to history and regional research issues.

The Terminal Pleistocene time segment (ca. 13,500-11,600 before present, calibrated using radiocarbon dating (cal BP)) is minimally represented and poorly understood in this region. What little evidence exists suggests that people passing through the area were wide-ranging, mobile hunters and gatherers who periodically exploited large game (Haynes 2002). Archaeological data from this time period, primarily represented by isolated fluted and/or bifacially thinned spear points and Pleistocene fauna remains, is limited to two cave sites in the study area.

The earliest evidence for occupation of the region largely falls between ca. 8000-5000 BP. Most assemblages dating to this interval are affiliated with the Borax Lake Pattern (Fredrickson 1974) and include wide-stemmed projectile points, handstones, milling slabs, and ovoid flake tools, along with a variety of other utilitarian items. The diversified nature of these artifact assemblages indicates people occupying the area were likely foragers who moved their residential bases frequently to exploit seasonal changes in resource distribution (Hildebrandt and Hayes 1983, 1993; Kowta et al. 2000; Sundahl and Henn 1993).

Several new projectile point forms appeared in the archaeological record around 5000 BP, including Squaw Creek Contracting-stemmed, Pollard Diamond-shaped, and McKee series. These points have been assigned to the Squaw Creek Pattern (5700-3200 BP) by Sundahl (1992b). Despite the appearance of these new forms, similarities in the rest of the assemblage composition with the preceding Borax Lake Pattern suggest people occupying the area during this time period were also relatively mobile foragers (Basgall and Hildebrandt 1989, Kowta et al. 2000).

A major change in the regional settlement-subsistence pattern appears to have occurred between ca. 4,000 to 1,600 years ago. This period has been identified as the Whiskeytown Pattern (Sundahl 1992b), and is represented by a wide range of corner- and side-notched projectile points assigned to the Clikapudi series, as well as hand stones, milling slabs, notched pebble net weights, and mortars and pestles (see also the Deadman and Kingsley complexes in Tehama County; Greenway 1982, Johnson 1984). Analysis of data from archaeological sites dating to this time period has led Basgall and Hildebrandt (1989) to propose a shift from the preceding generalized forager strategy to a “fission-fusion” model of subsistence-settlement where larger groups of people occupied residential camps during the fall and winter months, but then split into smaller foraging groups who moved between productive resource patches during the remainder of the year. The fall-winter residential sites are thought to have been concentrated along the northern Sacramento Valley foothills, where salmon and acorns could be readily obtained (Baker 1990, Bevill and Nilsson 1993, Sundahl 1999).

Two distinct patterns have been identified as corresponding with the most recent time period (from 1,600 years ago to contact) in the region. The first, referred to as the Augustine Pattern/Shasta Complex, is thought to reflect a more sedentary subsistence-settlement adaptation than what was practiced in the preceding time periods. Initially, from 1,250 to 750 years ago, square-stemmed Gunther Barbed projectile points (with lower frequencies of expanding-stem variants), winged drills, bipointed fish gorges, bone gaming pieces, incised bone pendants, and varied shell beads are characteristic. These materials have been associated with the arrival of the Wintu in Northern California, and are thought to reflect a sedentary adaptation made possible by a subsistence system dependent on the large-scale storage of salmon and acorns (Broughton 1988; George 1981; Sundahl 1982, 1992a; Wohlgemuth 1992).

During this same time frame, a contrasting record is found in upland areas surrounding the northern Sacramento Valley. It is represented by much smaller sites and rather simple assemblages consisting of small side- and corner-notched projectile points, a limited number of Gunther series forms, hopper mortars and pestles, hand stones, milling slabs, and notched pebble weights. On the east side of the valley, these findings are assigned to the Tehama Pattern (Clewett and Sundahl 1982, Sundahl 1992a), and are thought to reflect a more mobile pattern of settlement by populations speaking Hokan languages (e.g., Yana) pushed to the hinterlands by the late-arriving Wintu, who ultimately restricted access to the Sacramento River.

Ethnohistorical Context

Ethnohistorical investigations indicate that at the end of the prehistoric era and into the historic era, much of the study area was primarily occupied by the Wintu (LaPena 1978), but some of their territorial boundaries have been contested for many years. The most commonly accepted map of Wintu territory was produced by Du Bois (1935), and shows that the Wintu controlled the Sacramento, McCloud, and Squaw Creek drainages, and all but the easternmost segment of the Pit River Arm. This arm crosses into a boundary area between Northern Yana (Johnson 1978, Sapir and Spier 1943) and Achomawi (Pit River) tribes (Olmsted and Stewart 1978). Wintu people also lived along the Sacramento River from Shasta Dam down to the confluence of the river with Cottonwood and Battle creeks. Nomlaki territory took over south of Cottonwood Creek/Battle Creek and extended down past what is now the Red Bluff Pumping Plant (Goldschmidt 1951, 1978).

There has been a great deal of ethnohistoric and ethnographic discussion of the Wintu owing largely to the records amassed by late nineteenth- and early twentieth-century observers. Therefore, the Wintu can be considered one of the best known Native American groups in California. Most of the villages were located on the McCloud and Pit rivers and the general area south of the Pit River to just south of Redding. One hundred and six (43 percent) of the named Wintu ethnographic villages fall within the current study area.

Historical Context

The area that would become Shasta and Tehama counties was not explored by Europeans during the Spanish period of California history. Initial exploration occurred in 1821 when a Mexican expedition explored the Sacramento River nearly as far north as the future site of Redding, encountering Native populations as they traversed the region. Subsequently, European trappers in Northern California spread European diseases that had disastrous effects on the Native Americans. Notably, a devastating epidemic spread through the Sacramento Valley during the 1830s that may have killed as much as 75 percent of the native population.

In 1848, mining (especially for copper) began along the Trinity River and other Sacramento River tributaries, bringing as many as 50,000 people to the area. American immigrants increasingly occupied territory, and new logging and mining operations destroyed hunting grounds and salmon fisheries that were part of the traditional home of Native Americans such as the Wintu. Criminal violence and the policy of relocation to reservations nearly eliminated the Native American population in the upper Sacramento River Valley by 1870. Those who remained lived in the mountains, like the Wintu, who maintained a salmon fishery along the McCloud River.

The mining boom led to the construction of smelters, mills, and towns (such as Keswick) that flourished in the late 1800s and early 1900s. Falling copper prices, growing environmental concerns over pollution from smelters, and the U.S. Government’s efforts at protection and conservation of public lands ended major operations by the 1920s.

Logging started in 1852 and included sugar pine, white pine, red fir, and cedar. Sawmills quickly sprang up, along with associated roads. Transporting logs and milled lumber became easier after the completion of the railroad through Red Bluff and Redding, and the Blue Ridge Flume, completed in 1874. These transportation advances allowed lumber milling to be concentrated in the valley, and Red Bluff and other mill towns to thrive.

Agriculture dominated the valley land along the Sacramento River. Cattle farming was key initially, and remained an important product in the area through the mid-twentieth century, especially with the development of the dairy industry. Early settlers practiced dry farming, growing wheat and fruit, including peaches, pears, and plums. Farmers later diversified and transitioned from wheat to fruits, nuts, vineyards, and vegetable crops in the late 1800s through the 1920s. Ultimately, intensive irrigated agriculture dominated the area.

Throughout the historic era, transportation was an important focus of infrastructure development. Over time, foot travel and transportation by horse or stage coach on a number of historic trails gave way to river, railroad, and ultimately, automobile travel. Hopeful settlers and miners poured into the study area along the California-Oregon Trail between 1840 and 1860, passing through the upper Sacramento River and Pit River valleys. A segment of the Siskiyou Trail was used by the northern railroad in 1877 and Interstate 5 follows this route today. Many early roads in the study area operated in conjunction with ferries across the Sacramento River. Several important bridges are located in the study area, along with the remains of many others, including the Centennial Bridge in Red Bluff and the Dog Creek Bridge in Shasta County.

Towns such as Red Bluff, Redding, Keswick, and Kennett boomed, along with the region’s developing transportation network. The construction of Shasta and Keswick dams promoted a new period of prosperity that carried through the expansion of the lumber industry and the rise of the recreation industry in the mid-twentieth century.

Efforts to preserve the Nation’s forests began in the late 1800s. The Shasta Forest Reserve was created in 1905. The area also included many homesteads and Indian allotments granted to local Wintus in the 1880s. In preparation for inundation by Shasta Lake, the United States purchased land including these allotments, homesteads, and many other properties in the late 1930s. Around the same time, fish were recognized as an important natural resource in California, and the first of several salmon fish hatcheries were constructed in 1872 at the salmon spawning grounds near the confluence of the McCloud and Pit rivers.

Recreation, especially in the mountains, also played an important role in the region’s history. In the early twentieth century, private fishing clubs, such as the Bollibokka Club, flourished. In the 1930s, USFS began to encourage the recreational use of the forests by the broader public, constructing campgrounds and picnic areas. Recreation in the national forests expanded with the formation of Shasta Lake. New campgrounds were added, along with boat launches and access roads.

Hydroelectric power and water storage were also important facets of the region’s history. Starting in 1922, Pacific Gas and Electric Company built dams and power plants in the Pit River area. In 1935, the Federal Government decided to proceed with building the CVP to store and deliver Sacramento River water as far south as Fresno County. Work was completed in the 1940s at Shasta Dam and Keswick Dam and Powerhouse, located downriver from Shasta Dam. Power generated at Shasta Dam and transmitted to the CVP pumps provided electricity to supply the lift pumps raising water into the main canal system. The system used the natural channels of the Delta to move water from Redding to Tracy, the head of the Delta-Mendota Canal.

14.1.2 Archaeological Resources and Historical Structures

This section discusses known archaeological resources and historic structures within the primary study area.

Shasta Lake and Vicinity

A total of 134 cultural resources studies have been previously conducted that intersect or are fully contained within the Shasta Lake area. Of these, 80 percent were surveys, the remainder being overview/research designs, excavations, or other compliance reports. More than half of the surveys are considered to have had systematic coverage; the rest were either reconnaissance efforts or the methods were unknown. Overall, only 8 percent of the study area has been surveyed; 5 percent in a systematic manner and 3 percent using reconnaissance methods.

The records search identified 261 cultural resources within the study area, including 190 prehistoric sites, 45 historic-era resources, and 26 resources with both prehistoric and historic-era components.

The 215 recorded prehistoric-era resources and components are widely distributed throughout the study area and include the following:

- Forty-two major residential sites (thirteen with documented human remains)
- Thirty-seven residential sites
- Fifty-five artifact scatters
- Seventy-seven scatters of flaked stone tools and manufacturing debris
- Two caves
- Two sites of unknown character

The 71 recorded historic-era resources and components include the following:

- Thirteen structures, including seven bridges, one dam, one railroad bridge and grade, one aerial-tramway, one rock wall/alignment complex, one building foundation, and one concentration of wooden A-frames
- Seven linear features consisting of one railroad, five road segments and one line of wooden poles

- Seven mining locales that include two quarries and five sites with various mining-related features and residential elements.
- Fifteen artifact scatters
- Two ranching complexes
- Fourteen residential sites
- Two town complexes – both are mining-related and one includes a cemetery
- Two orchards represented by wooden poles and fruit trees
- One cemetery represented by two grave stones
- Seven historic-era Native American cemeteries, all but one of which is also associated with a major prehistoric residential component. Each of these cemeteries was subject to government removal of burials and reburial in a government cemetery outside the Shasta Lake inundation area and the current project area.
- One historic-era Native American residential site that also has a prehistoric residential component

Another 19 historic-era cemeteries (containing both Native American and Euro-American burials) within the footprint of Shasta Lake have not been formally recorded. They were subject to burial removal and subsequent reburial outside the reservoir area. It is possible that a number of these cemeteries may retain additional human remains, and are potentially subject to periodic exposure when the reservoir level fluctuates.

The vast majority of cultural resources discussed above have never been formally evaluated with respect to the eligibility for listing on the National Register of Historic Places (NRHP). The NRHP (also referred to as the National Register) is the Nation's official list of cultural resources worthy of preservation. Authorized under the National Historic Preservation Act of 1966 (NHPA), the NRHP is part of a national program to coordinate and support public and private efforts to identify, evaluate, and protect our historic and archeological resources. Properties listed in the NRHP include districts, sites, buildings, structures, and objects that are significant in American history, architecture, archeology, engineering, and culture. All properties and districts listed in or determined eligible for listing in the NRHP must be considered in the planning of Federal undertakings.

The Dog Creek Bridge is eligible for the NRHP. Shasta Dam and property has also been determined eligible for the NRHP as part of the CVP through a consensus determination with the State Historic Preservation Officer (SHPO). Another 24 resources have been determined ineligible by consensus determination with the SHPO. These include 15 historic-era resources, seven prehistoric sites, and two resources with both prehistoric and historic-era components. The remaining cultural resources have yet to be evaluated with respect to their eligibility for listing on the NRHP.

Upper Sacramento River (Shasta Dam to Red Bluff)

Based on the records search results, 97 cultural resources studies intersect or are fully contained within this area. Of these, 86 percent are surveys, along with overviews, excavation reports, and historical architectural evaluation reports. Most of the surveys had systematic coverage methods (75 percent). In all, 23 percent of the area has been surveyed, mostly by systematic methods (15 percent), and the rest by reconnaissance methods.

A total of 79 recorded cultural resources fall within this area. These include 45 prehistoric sites, 20 historic-era resources, and 14 resources with both historic-era and prehistoric components.

The 59 prehistoric resources and components within the study area include the following:

- Thirteen major residential sites
- Twenty-two residential sites
- Seven rock shelters
- Five artifact scatters
- Five flaked stone tool and manufacturing debris scatters
- Four rock art (petroglyph) sites
- Three sites of unknown character

The recorded prehistoric sites are concentrated in the southern portion of the study area, from Battle Creek near Table Mountain southward (71 percent), along with a small concentration of sites at the northern end of the upper Sacramento River area near Redding (18.6 percent). Eleven prehistoric sites have been subjected to some form of archaeological excavation.

The 34 recorded historic-era resources and components within the study area include the following:

- Ten structures
- Seven linear features consisting of five roads, one wagon train, and a powerline
- Five flume remnants (two of which were associated with orchards)
- Three mining locales, including a mining complex and two adits
- Five artifact scatters
- One ranching complex
- The historic-era structures include five bridges, a ferry crossing, a rock wall, a dam, one concrete dance pavilion, and a power substation building complex
- Three historic-era Native American residential sites

One archaeological site (referred to as the Benton Track Site or Magmas) is currently listed on the NRHP. In addition, the Diestelhorst Bridge in Redding and the Anderson-Cottonwood Irrigation District Diversion Dam have been determined eligible for the NRHP. Two sites are listed as ineligible for the NRHP by the California Office of Historic Preservation.

14.1.3 Native American Resources

A strong likelihood exists that other important Native American heritage locations are present within the study area, based on ethnohistoric data and initial discussions with Native Americans. The study area was the focus of intensive Native American occupation during historic times, with a variety of religious, economic, historic, and other values identified by Native American groups. Ten groups, including those listed by the Native American Heritage Commission, represent Native American interests in the study area. They include the Grindstone Indian Rancheria, Paskenta Band of Nomlaki Indians, Pit River Environmental Council, Pit River Tribe of California, Redding Rancheria, Shasta Indian Nation, United Tribe of Northern California, Inc., Winnemem Wintu, Wintu Educational and Cultural Council, and the Wintu Tribe of Northern California Toyon-Wintu Center. Notably, the Winnemem Wintu and the Pit River tribes live within the Shasta Lake area, where they continue to actively practice many aspects of their traditional culture. Both groups have related that a complex cultural landscape of village sites, ceremonial areas, burial sites, and resource areas intersects the study area.

The Winnemem Wintu also documented the location of some 155 ancestral villages within the Shasta Lake area. At least 81 village locations are known along the lower McCloud River and lower Pit River. An additional 73 villages are known to have existed on the eastern side of the Sacramento River. These village locations once contained between one and 30 houses each, some had associated cemeteries and each had a power place. Some of these villages are already under the waters of Shasta Lake, while others are just above the current Shasta Lake water level. The Winnemem Wintu have estimated that 120 of the known villages are still accessible (above the current high-water line).

Traditional Cultural Properties

Federal regulation defines Traditional Cultural Properties as properties that have "association with cultural practices or beliefs of a living community that (a) are rooted in that community's history, and (b) are important in maintaining the continuing cultural identity of the community" (Parker and King 1998). Examples of Traditional Cultural Properties include: a location associated with the traditional beliefs of a Native American group about its origins, its cultural history, or the nature of the world; a location where Native American religious practitioners have historically gone, and are known or thought to go today, to perform ceremonial activities in accordance with traditional cultural rules of practice.

The records search at the Information Center revealed that no Traditional Cultural Properties have been formally recorded in the study area.

It is important to note that a traditional cultural properties may not meet the NRHP criteria for a historic property and that, conversely, a historic property may not meet the criteria for a traditional cultural property. However, in those instances where an undertaking may affect a historic property that is also considered by an Indian group to be a site of beliefs, customs, and practices of a living community, circumstances may warrant that in the course of the Section 106 review process, consideration for accommodating access to and ceremonial use of the property and that avoidance of adverse physical effects in accordance with Section 106 are identified.

Tribal consultation has clearly indicated that local Native American groups are deeply concerned regarding the environmental and cultural effects of the project. Native Americans who supplied information for the SLWRI provided general information on the number and nature of resources both in the general region and in specific locations that could meet the definition of Traditional Cultural Properties, which are also supported in ethnohistoric studies.

Members of the Pit River Madesi Band stated that 22 ethnographic villages and associated burial grounds are located within the existing reservoir and proposed reservoir areas. One tribal member also noted that several Traditional Cultural Properties exist within the Pit 6 and Pit 7 Dam areas.

The Winnemem Wintu have identified important localities within the study area, many of which are locations where ceremonies are regularly conducted. Along the McCloud River, these include Children's Rock, Coyote Rock, Dekkas Rock, doctoring pools near Nawtawaket Creek, Eagle Rock and

Samwel Cave, Hirz Bay, *Kaibai* village, North Gray Rocks, Puberty Rock, Saddle Rock, and *Watawacket* village and spiritual area. Along the Sacramento River, important localities include the Antlers area, Delta area, Doney Creek, Gregory Creek, LaMoine area, Packers Bay, Pollard's area, middle Salt Creek, and Sims area. The Winnemem Wintu have strong traditional and contemporary connections with the land, and their ongoing use of many archaeological and religious sites is fundamental to the well-being of their culture, particularly the education of their youth.

Indian Sacred Sites

Executive Order No. 13007 defines an Indian sacred site as "any specific, discrete, narrowly delineated location on Federal land that is identified by an Indian tribe, or Indian individual determined to be an appropriately authoritative representative of an Indian religion, as sacred by virtue of its established religious significance to, or ceremonial use by, an Indian religion; provided that the tribe or appropriately authoritative representative of an Indian religion has informed the agency of the existence of such a site."

Executive Order 13007 pertains only to Federally recognized tribes and Federally managed lands. For groups that are not formally recognized, sacred areas may be listed in the Sacred Lands files of the California Native American Heritage Commission. This commission has reviewed its files and identified sacred lands within the study area, however these lands may or may not meet the definition under EO 13007. Their locations are confidential.

14.2 Regulatory Framework

Under Federal and State of California (State) law, effects to significant cultural resources—which include archaeological remains, historic-period structures, and Traditional Cultural Properties—must be considered as part of the environmental analysis of a proposed project. This section provides a summary of key regulations for the protection of significant resources.

14.2.1 Federal

National Historic Preservation Act

Under Section 106 of the NHPA, Federal agencies must consider effects to eligible resources ("historic properties") from the proposed undertaking, in consultation with SHPO and other parties. This includes affording the Advisory Council a reasonable opportunity to comment on such undertakings. This includes identification (usually through archival research, field inventories, public interpretation, and/or test evaluations) of cultural resources eligible for the NRHP, assessment of adverse effects to eligible properties, and resolution of adverse effects. The implementing regulations at 36 CFR Part 800 define procedures to meet Section 106 responsibilities through consultation among the

Federal agency and other parties with an interest in the effects on historic properties.

Section 106 defines significant archaeological or historical resources as those which are listed on, or eligible for listing on, the NRHP. Eligible properties are those that retain sufficient integrity and meet one or more of the following criteria: “(a)...are associated with events that have made a significant contribution to the broad patterns of our history; or (b) that are associated with the lives of persons significant in our past; or (c) that embody the distinctive characteristics of a type, period, or method of construction, or that represent a significant and distinguishable entity whose components may lack individual distinction; or (d) that have yielded, or may be likely to yield, information important in prehistory or history” (36 Code of Federal Regulations (CFR) 60.4).

Executive Order 13007 – Indian Sacred Sites

Indian Sacred Sites as addressed in Executive Order 13007 (24 May 1996) establishes that Federal agencies are responsible for allowing federally recognized American Indian religious practitioners access to and ceremonial usage of Indian sacred sites on Federal land. An Indian Sacred Site is defined as “any specific, discrete, narrowly delineated location on Federal land that is identified by an Indian tribe, or Indian individual determined to be an appropriately authoritative representative of an Indian religion, as sacred by virtue of its established religious significance to, or ceremonial use by, an Indian religion; provided that the tribe or appropriately authoritative representative of an Indian religion has informed the agency of the existence of such a site.” The agency will keep the locations of such sites confidential and will avoid adversely affecting the integrity of these sites. To assist in the implementation of this Executive Order, an interagency memorandum of understanding was signed to improve the protection of tribal access to Indian Sacred Sites through enhanced and improved interdepartmental coordination and collaboration. The Memorandum of Understanding Among the U.S. Department of Defense, U.S. Department of the Interior, U.S. Department of Agriculture, U.S. Department of Energy, and the Advisory Council on Historic Preservation Regarding Interagency Coordination and Collaboration for the Protection of Indian Sacred Sites, was executed on November 30, 2012, and remains in effect until December 31, 2017.

Native American Graves Protection and Repatriation Act

The Native American Graves Protection and Repatriation Act (Public Law 101-601; 25 United States Code 3001-3013) pertains to Native American burial sites and regulates the removal of human remains, funerary objects, sacred objects, and items of cultural patrimony on Federal and tribal lands. The Act requires permits for intentional removal or excavation of Native American human remains on Federal lands, covers cases of inadvertent discoveries, and dictates the ultimate disposition process of Native American human remains and cultural items.

American Indian Religious Freedom Act

The American Indian Religious Freedom Act (42 United States Code Section 1996) states that it is the policy of the United States to "protect and preserve for American Indians their inherent right of freedom to exercise the traditional religions of the American Indian, Eskimo, Aleut, and Native Hawaiians, including but not limited to access to sites, use and possession of sacred objects, and the freedom to worship through ceremonials and traditional rites." The provisions of American Indian Religious Freedom Act guarantee access to traditional sites on Federal lands for religious practices. Consultation under American Indian Religious Freedom Act with American Indian groups can simultaneously satisfy the requirements of NEPA.

Archaeological Resources Protection Act

The purpose of the Archaeological Resources Protection Act of 1979 (ARPA) (Public Law 95-96 – October 31, 1979) is to protect archaeological resources and sites that are located on public lands and Indian lands, and to foster increased cooperation between governmental authorities, the professional archaeological community, and private individuals in possession of archaeological resources. The act makes it unlawful to excavate, remove, or deface archaeological resources, to sell, purchase, or exchange those resources without applicable permit, and establishes criminal and civil penalties for any such violation.

Archaeological and Historic Preservation Act

This act was formerly known as the Reservoir Salvage Act of 1960, followed by the Moss-Bennet Act (Archaeological Recovery Act). The act can be found under 16 USC 469, and is intended to prevent irreparable loss or destruction of significant scientific, prehistorical, historical, or archeological data involving activities in connection with any Federal construction project or federally-licensed project, activity, or program through the recovery, protection, and preservation of such data, including preliminary survey or other investigation as needed.

14.2.2 State

Under CEQA, the lead non-Federal agency (state, county, city, or other) must consider potential effects to important or unique cultural resources. While the language and consultation process is somewhat different between the NHPA and CEQA, the definitions of eligible properties and of adverse impacts are essentially the same. Evaluations under CEQA consider a resource's potential eligibility to the California Register of Historical Resources.

California law also protects Native American burials, skeletal remains, and associated grave goods regardless of their antiquity, and provides for the sensitive treatment and disposition of those remains (California Health and Safety Code Section 7050.5, California Public Resources Code Sections 5097.94 et seq.).

14.2.3 Regulatory Compliance

Currently, there is no undertaking authorized by Congress involving the raising of Shasta Dam. Federal agencies may conduct nondestructive planning activities without completing Section 106, provided that the actions do not prohibit subsequent consideration of alternatives to avoid, minimize, or mitigate the undertaking's adverse effects on historic properties. This environmental document is in support of a feasibility study. Should the undertaking be authorized, Section 106 would resume early in that planning process (36 CFR Section 800. 1(c)).

Under Section 106, these efforts would include the following:

- A complete pedestrian survey and inventory of cultural resources within the area of potential effect (APE) of the selected alternative
- Ethnographic and ethnohistoric investigations to obtain greater detail regarding areas of importance to Native American tribes and groups
- Evaluations to determine whether cultural resources identified within the APE are eligible for inclusion in the NRHP
- Assessment of potential adverse effects to historic properties and consultation to resolve any identified adverse effects

Cultural resources are evaluated for inclusion in the NRHP based on criteria found at 36 CFR Part 60. Once a resource has been evaluated, the lead Federal agency determines eligibility in consultation with the SHPO and other consulting parties, as applicable. Where appropriate this process will include the USFS in the consultation to ensure appropriate consideration is given to the Shasta-Trinity National Forest Land and Resource Management Plan (STNF LRMP). The overall project actions, as authorized by Congress, may not be consistent with the STNF LRMP standards and guidelines (USFS 1995). A project-specific STNF LRMP amendment may be required for the standards associated with caves, visual quality, late successional reserves, riparian reserves, survey and manage species, and Shasta snow-wreath. The USFS decision would include a project specific exception to these standards.

In this process, previous determinations of eligibility may need to be reevaluated because of the passage of time or other factors, and it is important to acknowledge the special expertise of Indian tribes when assessing the eligibility of properties to which they attach ceremonial and cultural significance. It would be possible to evaluate some cultural resources with survey-level data. However, test excavations may be necessary to accurately evaluate many archaeological resources to determine if they are, in fact, historic properties.

The lead Federal agency is required to consider the effects of any potential project on historic properties within the APE. The criteria for assessing adverse effects are found in 36 CFR Part 800.5(a)(1), which states that “an adverse effect is found when an undertaking may alter, directly or indirectly, any characteristic of a historic property that qualify the property for inclusion in the National Register…” Examples of adverse effects include physical destruction, alteration, a change in the property’s setting, or the introduction of visual, atmospheric, or audible elements that diminish the integrity of the property’s significant historic features (36 CFR Part 800.5(a)(2)).

As part of the Section 106 process, the lead Federal agency is responsible for making a finding regarding whether the undertaking would have an adverse effect on historic properties. This assessment of adverse effects is made in consultation with SHPO, Indian tribes that attach religious and cultural significance to identified historic properties and other consulting parties. Reclamation would then seek concurrence on the findings of effect from the SHPO and the USFS, on National Forest Lands.

Consultation then continues among Reclamation, USFS, other applicable Federal agencies, SHPO, and other consulting parties on possible options for avoiding, minimizing, or mitigating the adverse effects. This includes notifying the Council when adverse effects are found and inviting the Council to participate. If SHPO, Reclamation, USFS, other applicable Federal agencies, and the Council (if participating) agree to measures to resolve adverse effects to historic properties, these are formalized in an MOA. Other consulting parties may be invited to sign the MOA. The Section 106 process (36 CFR Part 800.14) is completed once the terms of the MOA have been met. Alternatively, the Federal agencies may elect to enter into a programmatic agreement (PA) that would be developed as an alternative procedure to implement the Section 106 process (36 CFR Part 800.14). In rare cases, if consultation fails to result in agreement on resolving adverse effects, consultation may be terminated pursuant to the process detailed in 36 CFR Part 800.7.

14.3 Environmental Consequences and Mitigation Measures

This chapter is organized by the project alternatives described in Chapter 2, “Alternatives,” and discusses environmental consequences associated with implementation of the project alternatives. It also describes potential mitigation measures associated with impacts to cultural resources that are significant or potentially significant.

The environmental setting for this chapter includes only the primary study area, Shasta Lake and vicinity, and the upper Sacramento River between Shasta Dam and the Red Bluff Pumping Plant, as explained in Section 14.1. No potential impacts are expected in the extended study area; therefore, only impacts to cultural resources in the primary study area will be discussed. The extended study area is not discussed further in this section.

14.3.1 Impact Assessment Methods and Assumptions

The standard Section 106 process of the NHPA follows a series of steps that are described in the 36 CFR Part 800 regulations that implement the NHPA. These steps are as follows:

- Initiate Section 106 Process, 36 CFR Part 800.3
- Identify Historic Properties, 36 CFR Part 800.4
- Assess Adverse Effects, 36 CFR Part 800.5
- Resolve Adverse Effects, 36 CFR Part 800.6

"Adverse effects" are defined below in Section 14.3.2. In the event that historic properties within the APE for an undertaking would be subject to adverse effects, the lead Federal agency would consider ways to minimize or mitigate ("resolve") such effects, in consultation with the SHPO and other signatories and consulting parties. This often requires an MOA or PA among the consulting parties (Part 800.6).

Section 106 regulations allow Federal agencies to conduct "nondestructive project planning activities before completing compliance with Section 106" (36 CFR Part 800.1[c]), and the regulations encourage Federal agencies to consider a broad range of alternatives during the planning process for the undertaking. The SLWRI feasibility-level study is such a "nondestructive project planning" document, as there is no authorization for raising Shasta Dam at this time. Reclamation will not have a specific undertaking until such time as Congress makes a decision regarding whether to authorize a project that would involve raising the dam and appropriates funding for this purpose.

The purpose of the feasibility study has been to gather existing data that can be used in future environmental documents to estimate the impacts to the types of historic properties known to be present, based on existing data and consultations.

As part of compliance with 36 CFR Part 800 regulations, Reclamation conducted an analysis of the APE to assess which portions of the APE have been previously inventoried, and to identify all previously recorded cultural resources. Methods used for the cultural resources analysis included archival records searches (that identified previously recorded sites, site records, and Native American ethnographic studies), agency consultation, Native American consultations, and comparisons of the study alternatives. Information on archaeological and historical structures was obtained for sites within the primary study area that may be affected by alternative plans. Sensitivity analyses were also conducted for prehistoric and historic-era resources to address data gaps using methods tailored to each data set. Native American issues and resource locations within the primary study area were discussed during meetings with local Native American groups and individuals.

Also included in the analysis was an assessment of the effects of inundation and drawdown on cultural resources located within the pool of a reservoir. Previous reservoir studies have shown that the greatest impacts occur in the zone of inundation and drawdown (fluctuation zone), where cultural resources are repeatedly exposed to scouring, wave action, wet/dry cycles, and de-vegetation. This means that the most significant impacts will occur where an undertaking increases the size of the fluctuation zone–particularly if it includes areas that are above the current high-water line and thus have not previously been subject to inundation.

Archaeological and Historic-Era Structural Resources

The prior cultural resources inventory efforts and the resulting recorded cultural resources had been previously discussed in Section 14.1.2. Overall, the frequency and distribution of recorded sites within the project study area only give a limited and incomplete picture of the actual number of resources. This is because only a very small percentage of the project area has been systematically inventoried for cultural resources. To estimate site densities for the project area as a whole, sensitivity analysis was undertaken. Separate sensitivity analyses for prehistoric and historic-era sites were conducted to predict where unrecorded sites should be concentrated within unsurveyed areas. The resulting site-density predictions provide the most accurate estimate of site sensitivity by alternative available at present. The following discussion presents the methods and approach taken.

The archival research done for this study was designed to identify the types of cultural resources known to be present in the study area. However, the frequency and distribution of formally recorded resources give only a limited and incomplete picture of the actual number of resources. This is mainly due to limited systematic surveys comprising only 5 percent of the Shasta study area and 15 percent of the upper Sacramento River. As such, there are undoubtedly many more cultural resources that have not been identified or formally recorded.

A comparative sensitivity analysis was therefore conducted that took into account both documented and likely but undocumented resources (including archaeological sites and historic-era structures) for each of the alternatives proposed for raising Shasta Dam. The sensitivity analysis was restricted to the Shasta Lake and vicinity, and did not include the upper Sacramento River since no impact differences between alternatives have been identified within this area.

Separate sensitivity analyses using methods tailored to each data set were conducted for prehistoric and historic-era sites to estimate the total number of cultural resources present within each alternative (see Byrd et al. (2008) for methodological details and specific data). The prehistoric sensitivity analysis used a weights-of-evidence quantitative analysis to predict the overall density and distribution of sites. In contrast, the historic-era sensitivity analysis gathered archival data (mainly maps) within the study area to make predictions regarding the number and type of potential unrecorded historic-era resources (both structures and sites) by alternative. Results of the prehistoric and historic-era sensitivity analyses were integrated to provide quantitative estimates of the total number of cultural resources after full inventory. These estimates are for planning purposes only; additional pedestrian surveys would be needed if one of the affirmative alternatives were to go forward.

A second records search was completed to identify recorded cultural resources in specific areas of the upper Sacramento River where construction activities would take place in certain alternatives associated with ecosystem restoration, including spawning gravel augmentation and floodplain and riparian habitat restoration. For these construction areas, existing access roads were excluded, but a records search buffer of 0.25 mile was added to all other project elements. It should be noted that the proposed construction areas are concept-level, and may be relocated or deleted as a result of design development, consultation, or other factors.

Traditional Cultural Properties

Public and stakeholder coordination meetings were conducted on behalf of Reclamation with Indian tribes and Native American groups whose traditional territories overlap the study area to identify Traditional Cultural Properties, ceremonial locations, and other areas of concern to the Native American community. This included meetings and/or workshops with groups and individuals representing major tribes and/or extended family groups in the Shasta/Redding area regarding potential effects to cultural resources from a plan to enlarge Shasta Dam and Reservoir. The primary intent of these meetings was to strengthen communication with tribal groups and individuals; solicit, clarify, and document major concerns and issues; and establish a preferred method/approach to maintaining effective communication during the remainder of the SLWRI and in future endeavors.

Federally recognized Native American tribes were invited to begin the consultation process at an information meeting, followed by additional contact by telephone to learn of their concerns regarding the SLWRI, and to gain an initial sense of where sensitive resource localities are situated within the primary study area. Non-Federally recognized Native American groups and individuals with an interest in the study area were also contacted. There were also in-person visits to tribal members to collect information.

Seven tribal groups were invited to an information meeting held on April 4, 2007, in Redding, California. The purpose of the meeting was to provide general information about the SLWRI, initiate Section 106 consultation with groups desiring to participate in the project, and introduce Elena Nilsson, a consultant for Reclamation, as the Native American Tribal Coordination study lead. Invitations were sent to the groups shown in Table 14-1.

Table 14-1. Native American Groups Involved in Consultations

Native American Group
Grindstone Indian Rancheria of Wintun-Wailaki Indians[1]
Paskenta Band of Nomlaki Indians[1]
Pit River Tribe[1]
Redding Rancheria[1]
Shasta Indian Nation
Winnemem Wintu
Wintu Tribe of Northern California/Toyon-Wintu Center

Note:
[1] Federally recognized tribe as of 2012 (http://www.bia.gov/cs/groups/public/documents/text/idc-041248.pdf)

From August 2007 to March 2008, nine meetings were held with Native American groups whose traditional territories overlap with the SLWRI study area. The purpose of the meetings was to solicit, clarify, and document major concerns and issues regarding the project, and to establish a preferred method/approach to maintaining effective communication during the remainder of the SLWRI study and in future endeavors. Five groups participated in these meetings, including the Grindstone Indian Rancheria (one meeting), Paskenta Band of Nomlaki Indians (one meeting), Pit River Tribe (three meetings), Shasta Indian Nation (one meeting), and Winnemem Wintu (three meetings).

Currently, no formal Traditional Cultural Properties (as defined by Federal regulations) are formally recorded at the Information Center. The California Native American Heritage Commission, however, has stated that sacred lands (as defined by this commission) are present in the study area. Based on consultations, meetings, statements, letters, and public comments provided by Native Americans and previous ethnographic and ethnohistoric studies, it is predicted that a considerable number of Traditional Cultural Properties and other areas of special concern are present in the study area.

14.3.2 Criteria for Determining Significance of Effects

An environmental document prepared to comply with NEPA must consider the context and intensity of the environmental effects that would be caused by, or result from, the proposed action. Under NEPA, the significance of an effect is used to determine whether an EIS must be prepared. An environmental document prepared to comply with CEQA must identify the potentially significant environmental effects of a proposed project. A "[s]ignificant effect on the environment" means a substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by the project (State CEQA Guidelines, Section 15382). CEQA also requires that the environmental document propose feasible measures to avoid or substantially reduce significant environmental effects (State and CEQA Guidelines, Section 15126.4(a)).

Federal Criteria

Under Federal regulation (36 CFR Section 800(a)(1)):

> *"An adverse effect is found when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for inclusion in the National Register in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association. Consideration shall be given to all qualifying characteristics of a historic property, including those that may have been identified subsequent to the original evaluation of the property's eligibility for the National Register. Adverse effects may include reasonably foreseeable effects caused by the undertaking that may occur later in time, be farther removed in distance or be cumulative."*

Examples of adverse effects (36 CFR Section 800(a)(2)) include the following:

- Physical destruction, damage, or alteration, including moving the property from its historic location
- Isolation from, or alteration of, the setting
- Introduction of intrusive elements
- Neglect leading to deterioration or destruction
- Transfer, sale, or lease from Federal ownership

Adverse effects often can be resolved or mitigated through additional research, public education, and/or other means.

State Criteria

California regulations require that effects to cultural resources be considered only for resources meeting the criteria for eligibility to the California Register of Historical Resources, outlined in Section 5024.1 of the California Public Resources Code. Demolition, replacement, substantial alteration, or relocation of an eligible resource are actions that could change those elements of the resource which make it eligible. The following eligibility criteria were developed using guidance provided by the State CEQA Guidelines, and they consider the context and intensity of the environmental effects as required under NEPA. Under the State CEQA Guidelines, impacts on cultural resources may be considered significant if a project alternative would result in any of the following:

- Cause a substantial adverse change in the significance of a historical resource, as defined in Guidelines Section 15064.5
- Cause a substantial adverse change in the significance of an archaeological resource pursuant to Guidelines Section 15064.5
- Disturb human remains, including those interred outside formal cemeteries

According to the above criteria, the project would be considered to have a significant impact on cultural resources if it would result in any of the following:

- Substantial adverse change in the significance of an historical resource
- Substantial adverse change in the significance of a unique archaeological resource
- Disturbance or destruction of unique paleontological resource or site or unique geologic feature
- Disturbance of any human remains, including those interred outside of formal cemeteries
- Elimination of important examples of the major periods of California history or prehistory

Under CEQA an impact to a cultural resource can be reduced to a less-than-significant level through mitigation. Statements of impact significance are relative to both existing conditions (Year 2012) and future conditions (Year 2030), unless stated otherwise. Only those elements of a resource which contribute to its eligibility need to be considered; effects to noncontributing elements are less than significant.

14.3.3 Direct and Indirect Effects

This section describes the environmental consequences of the SLWRI alternatives, and proposed mitigation measures for any impacts determined to be significant or potentially significant.

No-Action Alternative

Dam construction, infrastructure and facilities relocation, additional reservoir area inundation, and construction activities adjacent to the upper Sacramento River would not occur under the No-Action Alternative. Therefore, no additional cultural resources above the current reservoir level would be impacted, and conditions would be the same as existing.

Shasta Lake and Vicinity

Impact Culture-1 (No-Action): Disturbance or Destruction of Archaeological and Historical Resources Due to Construction or Inundation Archaeological sites (as well as historic cemetery locations) within the existing Shasta Lake fluctuation zone will continue to be impacted by fluctuations in the height of the reservoir during ongoing operations with the No-Action Alternative. As stated above, dam construction, infrastructure and facilities relocation, and additional inundation as a result of the proposed action alternatives would not occur under the No-Action Alternative; therefore, no new impacts on cultural resources related to construction or inundation are expected. Mitigation is not required for the No-Action Alternative, as the proposed activities related to the action alternatives would not occur. Responsibilities to manage ongoing impacts from the No-Action Alternative may fall under other Federal or State laws which would be separate from any implementation requirements related to the action alternatives.

Impact Culture-2 (No-Action): Inundation of Traditional Cultural Properties Any Traditional Cultural Properties within the existing Shasta Lake fluctuation zone will continue to be impacted by fluctuations in the height of the reservoir during ongoing operations with the No-Action Alternative. As stated above, additional inundation as a result of the proposed action alternatives would not occur under the No-Action Alternative; therefore, no new impacts on cultural resources related to inundation are expected. Mitigation is not required for the No-Action Alternative. Responsibilities to manage ongoing impacts from the No-Action Alternative may fall under other Federal or State laws which would be separate from any implementation requirements related to the action alternatives.

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact Culture-3 (No-Action): Disturbance or Destruction of Archaeological and Historical Resources near the Upper Sacramento River Due to Construction Archaeological sites (as well as historic cemetery locations) in or near the upper Sacramento River will continue to be impacted by water operations with the No-Action Alternative. As stated above, construction activities adjacent to the upper Sacramento River would not occur under the No-Action Alternative; therefore, no impacts on cultural resources related to construction are expected. Mitigation is not required for the No-Action Alternative. Responsibilities to manage ongoing impacts from the No-Action Alternative may fall under other Federal or State laws which would be separate from any implementation requirements related to the action alternatives.

CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

Cultural resources potentially impacted by this alternative include those within: (1) the proposed additional 1,229-acre inundation area; (2) the portion of the proposed fluctuation zone for this alternative within the existing reservoir area; and (3) those portions of the 0.25-mile buffer around the reservoir where infrastructure would need to be relocated (recreation facilities, roads, utilities, trails, etc.). It should be noted that sites typically extend into the inundation and reservoir area for more than one alternative.

Shasta Lake and Vicinity

Impact Culture-1 (CP1): Disturbance or Destruction of Archaeological and Historical Resources Due to Construction or Inundation Raising Shasta Dam would have a direct impact on cultural resources. This impact would be significant. As noted, previous reservoir studies indicate that impacts are greatest in the zone of inundation and drawdown (fluctuation zone), where cultural resources are repeatedly exposed to scouring, wave action, wet/dry cycles, and de-vegetation. This means that the most significant impacts will occur where an undertaking increases the size of the fluctuation zone.

Sensitivity analyses, which are summarized at the beginning of this section, estimate that, with complete surveys, impacts associated with CP1 inundation and areas would include approximately 212±54 prehistoric resources (Table 14-2). The historic-era archival study documented 355 localities that may potentially contain historic-era remains within this inundation area.

Sensitivity analyses estimate that, with complete surveys, the CP1 fluctuation zone would include approximately 675±172 prehistoric resources. The historic-era archival study documented 529 localities that may potentially contain historic-era remains.

Table 14-2. Cultural Resources Impacts for CP1

Inundation Area	
Prehistoric sites	212±54
Historic-era archival localities	355
Fluctuation Zone	
Prehistoric sites	675±172
Historic-era archival localities	529
0.25-Mile Buffer	
All cultural resources	Fewer than CP2

Notes:
Mean prehistoric site estimates are based on weights-of-evidence quantitative analysis.
An undetermined number of sites will actually be subject to mitigation under NHPA Section 106.

Sensitivity analyses estimate that with complete surveys, the 0.25-mile buffer area for CP1 would include approximately 728±212 prehistoric resources. The historic-era archival study documented 773 localities that may potentially contain historic-era remains. Although the full extent and locations of project impacts within the buffer zone related to construction are not yet available for CP1, impacts would occur within only a small percentage of the overall buffer zone concentrated near the reservoir.

Although it is impossible at this stage to say how many of these resources will be determined eligible for listing under NHPA, and how many of the eligible resources will sustain adverse impacts from this alternative, this impact would be significant. Adverse effects will be avoided, minimized, or mitigated through project redesign, when warranted, or through the development and implementation of an MOA or PA, as discussed in Section 14.3.4.

Impact Culture-2 (CP1): Inundation of Traditional Cultural Properties Due to the confidential nature of sacred land filings, some sites have been identified within the study area, but specific locations are unknown. Several Native American groups have identified Traditional Cultural Properties and important ceremonial locations that would be adversely impacted by CP1. This impact would be significant.

In addition, places used for traditional practices that may be Traditional Cultural Properties have been identified within the study area. These locations are also confidential.

Two particularly important Winnemem Wintu ceremonial locations that would be impacted by CP1 include Puberty Rock and the doctoring pools near Nawtawaket Creek. CP1 could increase the frequency of inundation of Puberty Rock, restricting the Winnemem Wintu from holding the puberty ceremony at this important location during certain periods. Although Puberty Rock would still be accessible for portions of the year, when lake levels are lower, CP1 would increase the frequency of inundation. The relocation of the rock to higher ground is not possible, as, in the Winnemem worldview, its location is preordained and connected with the nearby “two sisters” mountain (Bollibokka Mountain). Puberty Rock also marks the location of an extensive village with housepits and burials. CP1 would inundate additional burials at this location, which would require removal and relocation. The Winnemem Wintu have estimated that 120 ancestral villages still accessible above the current high waterline of Shasta Lake would be adversely impacted by CP1.

The Pit River Madesi Band members state that 22 ethnographic villages, associated burial grounds, and several Traditional Cultural Properties are located within the existing reservoir and proposed inundation or fluctuation areas.

The local Native American community has identified several locations in the study area where ceremonial activities are carried out; notable among these are Puberty Rock and the doctoring pools near Nawtawaket Creek. Inundation or other adverse impacts to these places likely cannot be mitigated because the importance of the identified properties is inextricably tied to physical location, and relocation of these features away from the inundation area is not possible.

Although it is impossible at this stage to say how many of these resources will be adversely impacted due to inundation as a result of implementing CP1, this impact would be potentially significant. These sites cannot be relocated and continue their importance to Native American cultural practices. Adverse effects will be avoided, minimized, or mitigated through project redesign, when warranted, or through the development and implementation of an MOA or PA. However it is unlikely that effects would be resolved for many Traditional Cultural Properties. Mitigation for this impact is proposed in Section 14.3.4, but it is unlikely that adequate mitigation is available to reduce the impact to a less-than-significant level.

Upper Sacramento River (Shasta Dam to Red Bluff)
Impact Culture-3 (CP1): Disturbance or Destruction of Archaeological and Historical Resources near the Upper Sacramento River Due to Construction
Construction activities adjacent to the upper Sacramento River associated with downstream ecosystem enhancements would not occur under CP1; therefore, no impacts on significant cultural resources related to construction are expected. Mitigation for this impact is not needed, and thus not proposed.

CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

Cultural resources potentially impacted by this alternative include those within (1) the proposed additional 1,734-acre inundation area, (2) the portion of the proposed fluctuation zone for this alternative within the existing reservoir area, and (3) those portions of the 0.25-mile buffer around the reservoir where infrastructure would need to be relocated (recreation facilities, roads, utilities, trails, etc.).

Shasta Lake and Vicinity
Impact Culture-1 (CP2): Disturbance or Destruction of Archaeological and Historical Resources Due to Construction or Inundation Raising Shasta Dam and enlarging Shasta Reservoir would have a direct impact on cultural resources. This impact would be significant. Sensitivity analyses estimate that, with complete surveys, inundation associated with CP2 would include approximately 224±57 prehistoric resources (Table 14-3). The historic-era archival study documented 371 localities that may potentially contain historic-era remains within this inundation area.

Table 14-3. Cultural Resources Impacts for CP2

Inundation Area	
Prehistoric sites	224±57
Historic-era archival localities	371
Fluctuation Zone	
Prehistoric sites	675±172
Historic-era archival localities	529
0.25-Mile Buffer	
All cultural resources	Fewer than CP3

Notes:
Mean prehistoric site estimates are based on weights-of-evidence quantitative analysis.
An undetermined number of sites will actually be subject to mitigation under NHPA Sec. 106.

Sensitivity analyses estimate that, with complete surveys, the fluctuation zone for CP2 would include approximately 675±172 prehistoric resources. The historic-era archival study documented 529 localities that may potentially contain historic-era remains.

Sensitivity analyses estimate that, with complete surveys, the 0.25-mile buffer zone for CP2 would include approximately 728±212 prehistoric resources. The historic-era archival study documented 773 localities that may potentially contain historic-era remains. Although the full extent and locations of project impacts related to construction activities within the buffer zone are not yet available for this alternative, they would occur within only a small percentage of the overall buffer zone concentrated near the reservoir.

Although it is impossible at this stage to say how many of these resources will be determined eligible, and how many of the eligible resources will sustain adverse impacts from CP2, this impact would be significant. Inundation or other adverse impacts to affected resources likely cannot be mitigated because the importance of the identified properties and ceremonial locations is inextricably tied to physical location, and relocation of these features away from the inundation area is not possible. Adverse effects will be resolved through project redesign, when warranted, or through the development of an MOA or PA, as discussed in Section 14.3.4.

Impact Culture-2 (CP2): Inundation of Traditional Cultural Properties
Alternative CP2 is similar to Alternative CP1 with respect to the potential to cause significant impacts to Traditional Cultural Properties by inundation or affected by the fluctuation zone. The Native American Heritage Commission (NAHC) identified sacred land filings within the study area, and local Native American groups have provided information related to many locations in the inundation and fluctuation zone. These locations are generally confidential, thus making it unclear whether or not they are situated within the CP2 area. For the same reasons that apply to CP1, this impact would be significant. Adverse effects will be avoided, minimized, or mitigated through project redesign, when warranted, or through the development and implementation of an MOA or PA.

However it is unlikely that effects would be resolved for many Traditional Cultural Properties. Mitigation for this impact is proposed in Section 14.3.4, but it is unlikely that adequate mitigation is available to reduce the impact to a less-than-significant level.

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact Culture-3 (CP2): Disturbance or Destruction of Archaeological and Historical Resources near the Upper Sacramento River Due to Construction Construction activities adjacent to the upper Sacramento River associated with downstream ecosystem enhancements would not occur under CP2; therefore, no impacts on cultural resources related to construction are expected. Mitigation for this impact is not needed, and thus not proposed.

CP3 – 18.5-Foot Dam Raise, Anadromous Fish Survival and Agricultural Water Supply Reliability

Cultural resources potentially impacted by this alternative include those within (1) the proposed additional 2,497-acre inundation area, (2) the portion of the proposed fluctuation zone for this alternative within the existing reservoir area, and (3) those portions of the 0.25-mile buffer around the reservoir where infrastructure would need to be relocated (recreation facilities, roads, utilities, trails, etc.).

Shasta Lake and Vicinity

Impact Culture-1 (CP3): Disturbance or Destruction of Archaeological and Historical Resources Due to Construction or Inundation Raising Shasta Dam would have a direct impact on cultural resources. This impact would be significant. Sensitivity analyses estimate that, with complete surveys, inundation associated with CP3 would include approximately 243±63 prehistoric resources (Table 14-4). The historic-era archival study documented 391 localities that may potentially contain historic-era remains within this inundation area.

Table 14-4. Cultural Resources Impacts for CP3

Inundation Area	
Prehistoric sites	243±63
Historic-era archival localities	391
Fluctuation Zone	
Prehistoric sites	675±172
Historic-era archival localities	529
0.25-Mile Buffer	
All cultural resources	Fewer than CP5, same as CP4

Notes:
Mean prehistoric site estimates are based on weights-of-evidence quantitative analysis.
An undetermined number of sites will actually be subject to mitigation under NHPA Sec. 106.

Sensitivity analyses estimate that, with complete surveys, the fluctuation zone for CP3 would include approximately 675±172 prehistoric resources. The historic-era archival study documented 529 localities that may potentially contain historic-era remains.

Sensitivity analyses estimate that, with complete surveys, the 0.25-mile buffer zone for CP3 would include approximately 728±212 prehistoric resources. The historic-era archival study documented 773 localities that may contain historic-era remains. Although the full extent and locations of project impacts related to construction activities within the buffer zone are not yet available for this alternative, they would occur within only a small percentage of the overall buffer zone concentrated near the reservoir.

Although it is impossible at this stage to say how many of these resources will be determined eligible, and how many of the eligible resources will sustain adverse impacts from CP3, this impact would be significant. Inundation or other adverse impacts to affected resources likely cannot be mitigated because the importance of the identified properties and ceremonial locations is inextricably tied to physical location, and relocation of these features away from the inundation area is not possible. Adverse effects will be resolved through project redesign, when warranted, or through the development of an MOA or PA, as discussed in Section 14.3.4.

Impact Culture-2 (CP3): Inundation of Traditional Cultural Properties CP3 is similar to CP1 with respect to the potential to cause significant impacts to Traditional Cultural Properties by inundation or affected by the fluctuation zone. The NAHC identified sacred land filings within the study area, and local Native American groups have provided information related to many locations in the inundation and fluctuation zone. These locations are generally confidential, thus making it unclear whether or not they are situated within the CP3 area. Adverse effects will be avoided, minimized, or mitigated through project redesign, when warranted, or through the development and implementation of an MOA or PA. However it is unlikely that effects would be resolved for many Traditional Cultural Properties. Mitigation for this impact is proposed in Section 14.3.4, but it is unlikely that adequate mitigation is available to reduce the impact to a less-than-significant level.

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact Culture-3 (CP3): Disturbance or Destruction of Archaeological and Historical Resources near the Upper Sacramento River Due to Construction Construction activities adjacent to the upper Sacramento River associated with downstream ecosystem enhancements would not occur under CP3; therefore, no impacts on cultural resources related to construction are expected. Mitigation for this impact is not needed, and thus not proposed.

CP4 and CP4A – 18.5-Foot Dam Raise, Anadromous Fish Focus With Water Supply Reliability

Cultural resources potentially impacted by this alternative include those within (1) the proposed additional 2,497-acre inundation area, (2) the portion of the proposed fluctuation zone for this alternative within the existing reservoir area, and (3) those portions of the 0.25-mile buffer around the reservoir where infrastructure would need to be relocated (recreation facilities, roads, utilities, trails, etc.). CP4 and CP4A include downstream ecosystem enhancements with spawning gravel augmentation and floodplain and riparian habitat restoration, both of which would entail construction activities adjacent to the upper Sacramento River.

Shasta Lake and Vicinity

Impact Culture-1 (CP4 and CP4A): Disturbance or Destruction of Archaeological and Historical Resources Due to Construction or Inundation

Raising Shasta Dam would have a direct impact on cultural resources. This impact would be significant for CP4 or CP4A. Sensitivity analyses estimate that with complete surveys, inundation associated with CP4 and CP4A would include approximately 243±63 prehistoric resources (Table 14-5). The historic-era archival study documented 391 localities for CP4 and CP4A that may potentially contain historic-era remains within this inundation area.

Table 14-5. Cultural Resources Impacts for CP4 and CP4A

Inundation Area	**CP4**	**CP4A**
Prehistoric sites	243±63	243±63
Historic-era archival localities	391	391
Fluctuation Zone		
Prehistoric sites	601±154	675±172
Historic-era archival localities	524	529
0.25-Mile Buffer		
All cultural resources	Fewer than CP5, same as CP3	Fewer than CP5, same as CP3

Notes:
Mean prehistoric site estimates are based on weights-of-evidence quantitative analysis.
An undetermined number of sites will actually be subject to mitigation under NHPA Sec. 106.

Sensitivity analyses estimate that, with complete surveys, the fluctuation zone for CP4 would include approximately 601±154 prehistoric resources. Sensitivity analyses estimate that, with complete surveys, the fluctuation zone for CP4A would include approximately 675±172 prehistoric resources. The historic-era archival study documented 524 localities for CP4 and 529 localities for CP4A that may potentially contain historic-era remains.

Sensitivity analyses estimate that, with complete surveys, the 0.25-mile buffer zone for CP4 and CP4A would include approximately 728±212 prehistoric resources. The historic-era archival study documented 773 localities for CP4 and CP4A that may potentially contain historic-era remains. Although the full extent and locations of project impacts related to construction activities within the buffer zone are not yet available, they would occur within only a small percentage of the overall buffer zone concentrated near the reservoir.

Although it is impossible at this stage to say how many of these resources will be determined eligible, and how many of the eligible resources will sustain adverse impacts, this impact would be significant for CP4.

Although it is impossible at this stage to say how many of these resources will be determined eligible, and how many of the eligible resources will sustain adverse impacts, this impact would be significant for CP4A.

Inundation or other adverse impacts to affected resources likely cannot be mitigated because the importance of the identified properties and ceremonial locations is inextricably tied to physical location, and relocation of these features away from the inundation area is not possible. Adverse effects will be resolved through project redesign, when warranted, or through the development of an MOA or PA, as discussed in Section 14.3.4.

Impact Culture-2 (CP4 and CP4A): Inundation of Traditional Cultural Properties CP4 and CP4A are similar to CP1 with respect to the potential to cause significant impacts to Traditional Cultural Properties by inundation or affected by the fluctuation zone. The NAHC identified sacred land filings within the study area, and local Native American groups have provided information related to many locations in the inundation and fluctuation zone. These locations are generally confidential, thus making it unclear whether or not they are situated within the CP4 and CP4A area. For the same reasons that apply to CP1, this impact would be significant. Adverse effects will be avoided, minimized, or mitigated through project redesign, when warranted, or through the development and implementation of an MOA or PA. However it is unlikely that effects would be resolved for many Traditional Cultural Properties. Mitigation for this impact is proposed in Section 14.3.4, but it is unlikely that adequate mitigation is available to reduce the impact to a less-than-significant level.

Upper Sacramento River (Shasta Dam to Red Bluff)

Impact Culture-3 (CP4 and CP4A): Disturbance or Destruction of Archaeological and Historical Resources near the Upper Sacramento River Due to Construction Previous cultural resource studies indicated the presence of cultural resources in or near proposed downstream construction areas related to spawning gravel augmentation and floodplain and riparian habitat restoration. This impact would be significant for CP4 or CP4A.

A total of 17 cultural resources have been recorded within the records search areas, consisting of eight prehistoric sites, six historic-era resources, and three resources with prehistoric and historic-era components. As mapped, thirteen of these cultural resources exist only in the 1/8-mile buffer areas, and only four of these cultural resources extend into proposed construction areas. It should be noted that the proposed construction areas are concept-level and may be relocated or deleted as a result of design development, consultation, or other factors.

Although it is impossible at this stage to say how many eligible resources will sustain adverse impacts from CP4 or CP4A, this impact would be significant. Adverse effects will be resolved through project redesign, when warranted, or through the development of an MOA or PA, as discussed in Section 14.3.4.

CP5 – 18.5-Foot Dam Raise, Combination Plan

Cultural resources potentially impacted by this alternative include those within (1) the proposed additional 2,497-acre inundation area, (2) the portion of the proposed fluctuation zone for this alternative within the existing reservoir area, and (3) those portions of the 0.25-mile buffer around the reservoir where infrastructure would need to be relocated (recreation facilities, roads, utilities, trails, etc.). CP5 also includes downstream ecosystem enhancements with spawning gravel augmentation and floodplain and riparian habitat restoration, both of which would entail construction activities adjacent to the upper Sacramento River.

Shasta Lake and Vicinity

Impact Culture-1 (CP5): Disturbance or Destruction of Archaeological and Historical Resources Due to Construction or Inundation Raising Shasta Dam would have a direct impact on cultural resources. This impact would be significant. Sensitivity analyses estimate that, with complete surveys, inundation associated with CP5 would include approximately 243±63 prehistoric resources (Table 14-6). The historic-era archival study documented 391 localities that may potentially contain historic-era remains within this inundation area.

Table 14-6. Cultural Resources Impacts for CP5

Inundation Area	
Prehistoric sites	243±63
Historic-era archival localities	391
Fluctuation Zone	
Prehistoric sites	675±175
Historic-era archival localities	529
0.25-Mile Buffer	
All cultural resources	Largest quantity

Notes:
Mean prehistoric site estimates are based on weights-of-evidence quantitative analysis.
An undetermined number of sites will actually be subject to mitigation under NHPA Sec. 106.

Sensitivity analyses estimate that, with complete surveys, the fluctuation zone for CP5 would include approximately 675±172 prehistoric resources. The historic-era archival study documented 529 localities that may potentially contain historic-era remains.

Sensitivity analyses estimate that, with complete surveys, the 0.25-mile buffer zone for CP5 would include approximately 728±212 prehistoric resources. The historic-era archival study documented 773 localities that may potentially contain historic-era remains. Although the full extent and locations of project impacts related to construction activities within the buffer zone are not yet available for this alternative, they would occur within only a small percentage of the overall buffer zone concentrated near the reservoir.

Although it is impossible at this stage to say how many of these resources will be determined eligible, and how many of the eligible resources will sustain adverse impacts from CP5, this impact would be significant. Inundation or other adverse impacts to affected resources likely cannot be mitigated because the importance of the identified properties and ceremonial locations is inextricably tied to physical location, and relocation of these features away from the inundation area is not possible. Adverse effects will be resolved through project redesign, when warranted, or through the development of an MOA or PA, as discussed in Section 14.3.4.

Impact Culture-2 (CP5): Inundation of Traditional Cultural Properties
Alternative CP5 is similar to Alternative CP1 with respect to the potential to cause significant impacts to Traditional Cultural Properties by inundation or affected by the fluctuation zone. The NAHC identified sacred land filings within the study area, and local Native American groups have provided information related to many locations in the inundation and fluctuation zone. These locations are generally confidential, thus making it unclear whether or not they are situated within the CP5 area. For the same reasons that apply to CP1, this impact would be significant. Adverse effects will be avoided, minimized, or mitigated through project redesign, when warranted, or through the development and implementation of an MOA or PA. However it is unlikely that effects would be resolved for many Traditional Cultural Properties. Mitigation for this impact is proposed in Section 14.3.4, but it is unlikely that adequate mitigation is available to reduce the impact to a less-than-significant level.

Upper Sacramento River (Shasta Dam to Red Bluff)
Impact Culture-3 (CP5): Disturbance or Destruction of Archaeological and Historical Resources near the Upper Sacramento River Due to Construction
This impact would be significant. Previous cultural resource studies indicated the presence of cultural resources in or near proposed downstream construction areas related to spawning gravel augmentation and floodplain and riparian habitat restoration.

A total of 17 cultural resources have been recorded within the records search areas, consisting of eight prehistoric sites, six historic-era resources, and three resources with prehistoric and historic-era components. As mapped, thirteen of these cultural resources exist only in the 1/8-mile buffer areas, and only four of these cultural resources extend into proposed construction areas. It should be noted that the proposed construction areas are concept-level and may be relocated or deleted as a result of design development, consultation, or other factors.

Although it is impossible at this stage to say how many eligible resources will sustain adverse impacts from CP5, this impact would be significant. Adverse effects will be resolved through project redesign, when warranted, or through the development of an MOA or PA, as discussed in Section 14.3.4.

14.3.4 Mitigation Measures

This section discusses mitigation measures for each significant impact described in the environmental consequences section, as presented in Table 14-7. In coordination with project designers, there will be opportunities to avoid, minimize, or mitigate adverse effects to historic properties through project redesign or through the development of an MOA or PA. An MOA or PA will ensure compliance with Section 106 and resolution of adverse effects.

Table 14-7. Summary of Mitigation Measures for Cultural Resources

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/ CP4A	CP5
Impact Culture-1: Disturbance or Destruction of Archaeological and Historical Resources Due to Construction or Inundation	LOS before Mitigation	NI	S	S	S	S	S
	Mitigation Measure	None required.	Mitigation Measure Culture-1: Develop and Implement measures identified in an NHPA Section 106 MOA or PA				
	LOS after Mitigation	NI	LTS	LTS	LTS	LTS	LTS
Impact Culture-2: Inundation of Traditional Cultural Properties	LOS before Mitigation	NI	S	S	S	S	S
	Mitigation Measure	None required.	Mitigation Measure Culture-2:Adverse effects will be avoided, minimized, or mitigated through project redesign, when warranted, or through the development and implementation of an MOA or PA				
	LOS after Mitigation	NI	SU	SU	SU	SU	SU

Table 14-7. Summary of Mitigation Measures for Cultural Resources (contd.)

<table>
<tr><th>Impact</th><th></th><th>No-Action Alternative</th><th>CP1</th><th>CP2</th><th>CP3</th><th>CP4/ CP4A</th><th>CP5</th></tr>
<tr><td rowspan="3">Impact Culture-3: Disturbance or Destruction of Archaeological and Historical Resources near the Upper Sacramento River Due to Construction</td><td>LOS before Mitigation</td><td>NI</td><td>NI</td><td>NI</td><td>NI</td><td>S</td><td>S</td></tr>
<tr><td>Mitigation Measure</td><td>None required.</td><td colspan="3">No mitigation needed; thus, none proposed.</td><td colspan="2">Mitigation Measure Culture-3: Implement Mitigation Measure Culture-1: Develop and Implement measures identified in an NHPA Section 106 MOA or PA</td></tr>
<tr><td>LOS after Mitigation</td><td>NI</td><td>NI</td><td>NI</td><td>NI</td><td>LTS</td><td>LTS</td></tr>
</table>

Key:
LOS = level of significance
LTS = less than significant
MOA = Memorandum of Agreement
NHPA = National Historic Preservation Act
NI = No Impact
PA = Programmatic Agreement
S = significant
SU = significant and unavoidable

No-Action Alternative

No mitigation measures are required for this alternative.

CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

As this alternative is likely to cause significant, adverse impacts to historic properties, it will be necessary to mitigate those impacts.

Mitigation Measure Culture-1 (CP1): Develop and Implement measures identified in an NHPA Section 106 MOA or PA Avoid, minimize, or mitigate adverse effects through project redesign, when warranted, or through the development and implementation of an MOA or PA.

These impacts would be less than significant after mitigation.

Mitigation Measure Culture-2 (CP1) Avoid, minimize, or mitigate adverse effects to Traditional Cultural Properties through project redesign, when warranted, or through the development and implementation of an MOA or PA.

This impact would remain significant and unavoidable after mitigation.

CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

As this alternative is likely to cause significant, adverse impacts to historic properties, it will be necessary to mitigate those impacts.

Mitigation Measure Culture-1 (CP2): Develop and Implement measures identified in an NHPA Section 106 MOA or PA Avoid, minimize, or mitigate adverse effects through project redesign, when warranted, or through the development and implementation of an MOA or PA.

These impacts would be less than significant after mitigation.

Mitigation Measure Culture-2 (CP2) Avoid, minimize, or mitigate adverse effects to Traditional Cultural Properties through project redesign, when warranted, or through the development and implementation of an MOA or PA.

This impact would remain significant and unavoidable after mitigation.

CP3 – 18.5-Foot Dam Raise, Anadromous Fish Survival and Agricultural Water Supply Reliability

As this alternative is likely to cause significant, adverse impacts to historic properties, it will be necessary to mitigate those impacts.

Mitigation Measure Culture-1 (CP3): Develop and Implement measures identified in an NHPA Section 106 MOA or PA Avoid, minimize, or mitigate adverse effects through project redesign, when warranted, or through the development and implementation of an MOA or PA.

These impacts would be less than significant after mitigation.

Mitigation Measure Culture-2 (CP3) Avoid, minimize, or mitigate adverse effects to Traditional Cultural Properties through project redesign, when warranted, or through the development and implementation of an MOA or PA.

This impact would remain significant and unavoidable after mitigation.

CP4 and CP4A – 18.5-Foot Dam Raise, Anadromous Fish Focus With Water Supply Reliability

As CP4 or CP4A are likely to cause significant, adverse impacts to historic properties, it will be necessary to mitigate those impacts.

Mitigation Measure Culture-1 (CP4 and CP4A): Develop and Implement measures identified in an NHPA Section 106 MOA or PA Avoid, minimize, or mitigate adverse effects through project redesign, when warranted, or through the development and implementation of an MOA or PA.

These impacts would be less than significant after mitigation.

Mitigation Measure Culture-2 (CP4 and CP4A) Avoid, minimize, or mitigate adverse effects to Traditional Cultural Properties through project redesign, when warranted, or through the development and implementation of an MOA or PA.

This impact would remain significant and unavoidable after mitigation.

Mitigation Measure Culture-3 (CP4 and CP4A): Implement Mitigation Measure Culture-1 (CP4 and CP4A): Develop and Implement measures identified in an NHPA Section 106 MOA or PA This mitigation measure is the same as Mitigation Measure Culture-1 (CP4 and CP4A). Implementation of Mitigation Measure Culture-1 (CP4 and CP4A) would reduce Impact Culture-3 (CP4 and CP4A) to a less than significant level.

CP5 – 18.5-Foot Dam Raise, Combination Plan

As this alternative is likely to cause significant, adverse impacts to historic properties, it will be necessary to mitigate those impacts.

Mitigation Measure Culture-1 (CP5): Develop and Implement measures identified in an NHPA Section 106 MOA or PA Avoid, minimize, or mitigate adverse effects through project redesign, when warranted, or through the development and implementation of an MOA or PA.

These impacts would be less than significant after mitigation.

Mitigation Measure Culture-2 (CP5) Avoid, minimize, or mitigate adverse effects to Traditional Cultural Properties through project redesign, when warranted, or through the development and implementation of an MOA or PA.

This impact would remain significant and unavoidable after mitigation.

Mitigation Measure Culture-3 (CP5): Implement Mitigation Measure Culture 1 (CP5): Develop and Implement measures identified in an NHPA Section 106 MOA or PA This mitigation measure is the same as Mitigation Measure Culture-1 (CP5). Implementation of Mitigation Measure Culture-1 (CP5) would reduce Impact Culture-3 (CP5) to a less than significant level.

14.3.5 Cumulative Effects

Chapter 3, “Considerations for Describing the Affected Environment and Environmental Consequences,” gives an overview of the cumulative effects analysis, including significance criteria, and discusses the relationship of this analysis to the CALFED Programmatic Cumulative Impacts Analysis. Table 3-1, “Present and Reasonably Foreseeable Future Actions Included in the Analysis of Cumulative Impacts, by Resource Area,” in Chapter 3, lists the projects considered quantitatively and qualitatively within the cumulative impacts analysis. This cumulative impacts analysis accounts for potential project impacts combined with the impacts of existing facilities, conditions, land uses, and reasonably foreseeable actions expected to occur in the study area on a qualitative and quantitative level. None of the programs or projects listed in Table 3-1 under Quantitative Analysis would impact cultural resources in the primary study, nor overlap with resources affected in the extended study area. The remainder of this analysis is focused on programs and projects in the Qualitative Analysis section of Table 3-1.

Past programs and projects have impacted cultural resources in the primary and extended study area through land use changes, inundation, erosion, construction, abandonment and illegal activities. The past projects such as Shasta Dam and Reservoir, road construction, and recreation development have cumulatively impacted cultural resources. Reasonably foreseeable projects listed on Table 3-1 that may impact cultural resources include but are not limited to Antlers Bridge Replacement, Moody Flats Quarry, and Mountain Gate at Shasta Mixed Use Area Plan. The project alternatives would result in a cumulatively considerable incremental contribution to a significant cumulative impact related to effects on cultural resources in the primary study area. Also in the Upper Sacramento River (Shasta Dam to Red Bluff) region of the extended study area, the project would result in a cumulatively considerable incremental contribution to a significant cumulative impact on cultural resources. The SLWRI alternatives would not impact cultural resources in other areas of the extended study area, so there would be no cumulative impacts from the project in these areas.

This page left blank intentionally.

Chapter 15
Indian Trust Assets

15.1 Affected Environment

This section describes the affected environment related to Indian Trust Assets (ITA) for the proposed dam and reservoir modifications under SLWRI action alternatives.

The affected environment for ITAs is the primary study area, within which all construction activities will take place, and which includes Shasta Lake's expanded inundation area, relocations within approximately 0.25 miles of the shoreline, and the upper Sacramento River from Shasta Dam to the Red Bluff Pumping Plant.

The extended study area would only be affected by changes in CVP and SWP operations, and includes the Sacramento River to the Delta and the CVP and SWP water service areas. For additional details on the primary and extended study areas, please refer to Section 1.3 and Figures 1-1 and 1-2 of the EIS. Since the action alternatives are not anticipated to have potential impacts to ITAs as a result of changes in CVP and SWP operations, an analysis of potential impacts to ITAs was determined unwarranted.

Indian Trust Lands in the region around the primary study area are shown in Figure 15-1.

Several Federally recognized tribes are located in the region surrounding the primary study area (Table 15-1).

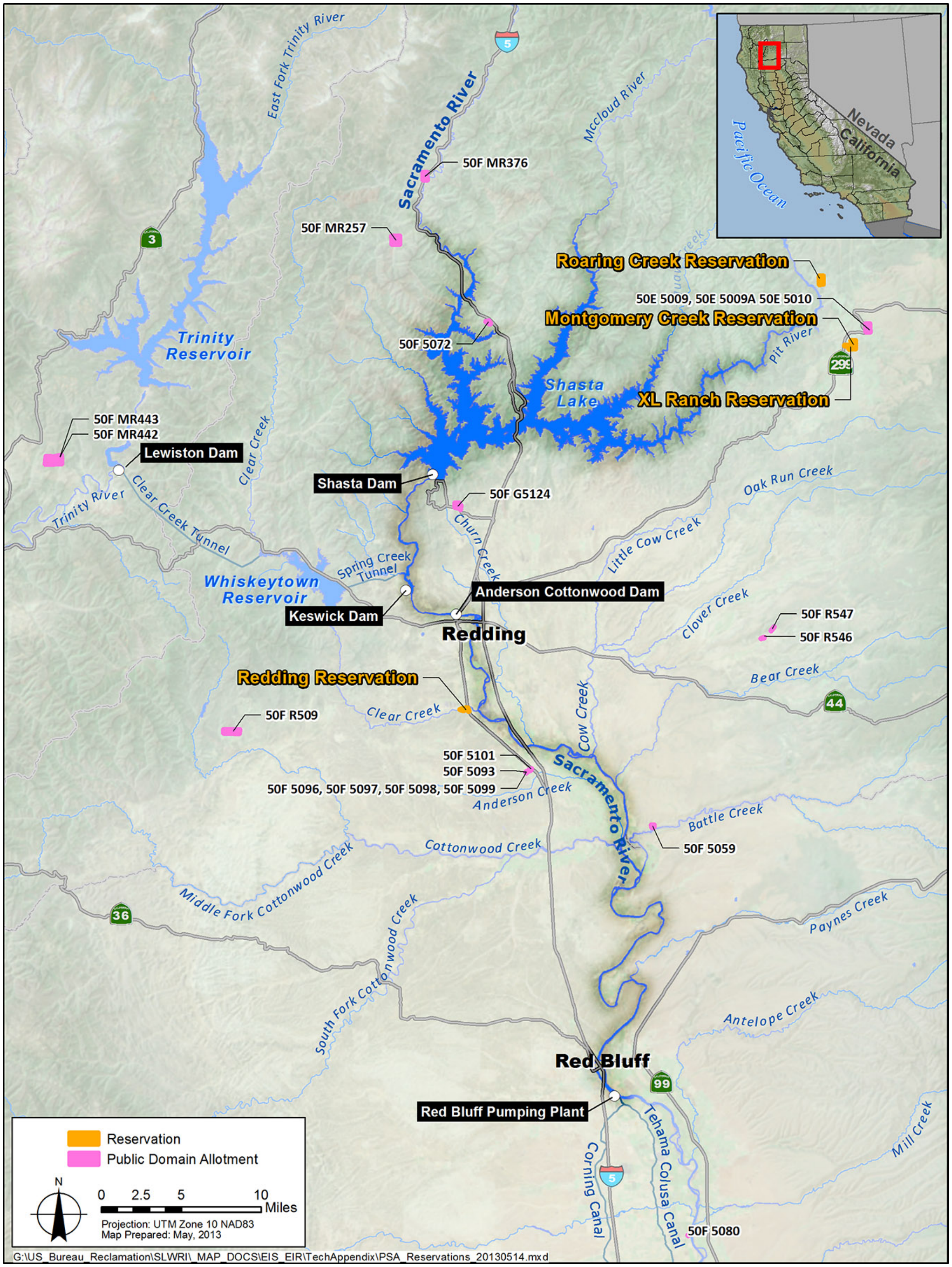


Figure 15-1. Reservations, Rancherias and Public Domain Allotments in Primary Study Area

Table 15-1. Federally Recognized Tribes in Region Surrounding Primary Study Area

Tribe	Affiliation
Grindstone Indian Rancheria of Wintun- Wailaki Indians	Wintun, Wailaki
Paskenta Band of Nomlaki Indians	Nomlaki
Pit River Tribe Environmental Office	Pit River, Wintun
Pit River Tribe	Pit River Achumawi Wintun
Redding Rancheria	Wintu, Pit River, Yana

15.2 Regulatory Framework

ITAs are legal interests in property held in trust by the U.S. for Federally recognized Indian tribes or individual Indians. An Indian trust has three components: (1) the trustee, (2) the beneficiary, and (3) the trust asset. ITAs can include land, minerals, Federally reserved hunting and fishing rights, Federally reserved water rights, and in-stream flows associated with trust land. Beneficiaries of the Indian trust relationship are Federally recognized Indian tribes with trust land; the United States is the trustee. By definition, ITAs cannot be sold, leased, or otherwise encumbered without approval of the United States. The characterization and application of the United States trust relationship have been defined by case law that interprets Congressional acts, executive orders, and historic treaty provisions.

The Federal Government, through treaty, statute, or regulation, may take on specific, enforceable fiduciary obligations that give rise to a trust responsibility to Federally recognized tribes and individual Indians possessing trust assets. Courts have recognized an enforceable Federal fiduciary duty with respect to Federal supervision of Indian money or natural resources, held in trust by the Federal Government, where specific treaties, statutes, or regulations create such a fiduciary duty.

Consistent with President William J. Clinton's 1994 memorandum, *Government-to-Government Relations with Native American Tribal Governments* (Federal Register, Vol. 59, No. 85, May 4, 1994, pages 22951–22952), Reclamation assesses the effect of its programs on tribal trust resources and Federally recognized tribal governments. Reclamation is tasked to actively engage Federally recognized tribal governments and consult with such tribes on a government-to-government level when its actions affect ITAs. The U.S. Department of the Interior Departmental Manual, Part 512.2 (1995), ascribes the responsibility for ensuring protection of ITAs to the heads of bureaus and offices. The Department of the Interior is required to "protect and preserve Indian trust assets from loss, damage, unlawful alienation, waste, and depletion" (Secretarial Order No. 3215, *Principles for the Discharge of the Secretary's Trust Responsibility*, Reclamation 2000). It is the general policy of the

Department of the Interior to perform its activities and programs in such a way as to protect ITAs and avoid adverse effects whenever possible. Reclamation complies with procedures contained in Departmental Manual, Part 512.2, guidelines, which protect ITAs. Reclamation carries out its activities in a manner that protects trust assets and avoids adverse impacts, when possible. When Reclamation cannot avoid adverse impacts, it will provide appropriate mitigation or compensation. Reclamation is responsible for assessing whether action alternatives CP1 through CP5 have the potential to affect ITAs. Reclamation will comply with procedures contained in Departmental Manual, Part 512.2, guidelines, which protect ITAs.

15.3 Environmental Consequences and Mitigation Measures

This section discusses environmental consequences and potential mitigation associated with ITAs that could result from implementing the alternatives described in this EIS.

15.3.1 Methods and Assumptions

A detailed description of both the primary and extended study areas was provided to the Bureau of Indian Affairs' Regional ITA Coordinator. The Regional ITA Coordinator examined both the project area descriptions and records held by the Bureau of Indian Affairs and Reclamation, and determined that the proposed action does not have potential to affect ITAs. There are no ITAs in the primary study area.

15.3.2 Direct and Indirect Effects

The following section describes the potential environmental consequences of the project.

No-Action Alternative

Under the No-Action Alternative, there are no potential impacts to ITAs because no new facilities would be constructed and existing operations would continue as historically.

CP1 Through CP5

There are no tribes possessing legal property interests held in trust by the United States in the study area for any of the proposed comprehensive plans (CP1 through CP5). The nearest ITA is a Public Domain Allotment approximately 5 miles north-northwest of the project location. This property would not be affected by inundation from the enlarged reservoir or have ground disturbing activities.

Cumulative Impacts

There are no potential impacts to ITAs as a result of the proposed action; therefore, the proposed action would not contribute to cumulative impacts to ITAs.

Chapter 16
Socioeconomics, Population, and Housing

16.1 Affected Environment

This chapter describes socioeconomics, population, and housing characteristics in the primary and extended study areas. For a more detailed discussion of the information presented in this chapter, see the *Socioeconomics, Population, and Housing Technical Report*.

16.1.1 Socioeconomics

Socioeconomics covers age, race/ethnicity, income/poverty, employment and labor force, business and industry, and government and finance. For a more detailed discussion of the information presented in this chapter, see the *Socioeconomics, Population, and Housing Technical Report*.

Shasta Lake and Vicinity and Upper Sacramento River (Shasta Dam to Red Bluff)

Race/Ethnicity In 2010, the white population represented more than 90 percent of the populations of Shasta and Tehama counties, but substantial increases were observed in many minority groups (U.S. Census Bureau 2010a). Tehama County's minority populations also increased between 2000 and 2010. Trends observed in the two counties generally coincide with statewide trends; Hispanic, Asian-Pacific Islander, and American Indian populations all grew by more than 9 percent over the 10-year period.

Income/Poverty Jurisdictions within the primary study area have underperformed when compared to the statewide averages for income levels and poverty rates. Median household incomes in Shasta and Tehama counties were sizably lower than the statewide average in 2000 and 2010, although Shasta County experienced a substantial increase in the 10-year period. With median household incomes of $42,931 and $39,392 in 2010, respectively, Shasta and Tehama counties had incomes averaging between $17,000 and $20,000 less than the statewide average for 2010 (U.S. Census Bureau 2011a). Overall poverty rates and child poverty rates also have been higher in the primary study area than in the State of California (State) as a whole.

Employment and Labor Force Because of the cyclical nature of the area's natural resource-related industries and other factors, Shasta and Tehama counties were characterized by substantially higher unemployment rates during the 1990s (Shasta County 2004). Unemployment rates in both counties have continued to increase and have exceeded State rates since 2007. From 2007 through 2010, unemployment rates in the two counties ranged between 1.8 percent and 3.3 percent above the statewide rate. The two counties recorded similar unemployment rates (varying between 0.1 and 0.7 percent) since 2007. In 2010, Tehama County registered a 15.6 percent unemployment rate, while unemployment in Shasta County totaled 15.7 percent of the population (EDD 2010a). As a result of its larger population, Shasta County maintained a labor force of just under 84,400 people in 2010, or more than three times that of Tehama County.

Business and Industry Economic activities in the primary study area coincide in many ways with the industrial composition of California as a whole. Education and health services, followed by governmental services, made up the top two industrial sectors both locally and statewide in 2010. In Shasta and Tehama counties, employees in the education and health services, which includes teachers and health workers, and government employees accounted for more than 40 percent of the total workforce. Similarly, retail trade, which includes general merchandise stores, food and beverage stores, and other miscellaneous stores and retailors, also ranks in the top five industries in both counties and California generally.

Some differences also exist between the industrial makeup of the two counties and that of California as a whole. For example, manufacturing plays an important role in Tehama County (7.6 percent) and California (10.0 percent) as a whole, but a comparatively small role in Shasta County. Professional and business services registers as the third largest industry at the statewide level (12.5 percent), but represents a smaller portion of employment in Shasta County (9.7 percent) and Tehama County (7.0 percent). Additionally, farm employment makes up a sizeable portion of the total workforce in Tehama County (8.3 percent), but accounts for a comparatively small portion of the workforce in Shasta County (3.1 percent) and California as a whole (2.3 percent).

Projections of future growth depict slightly different economic trends in Shasta and Tehama counties than at the statewide level. California’s construction industry is expected to grow by 26 percent by 2020 (compared to 2010 levels), and the wholesale trade industry is expected to grow by more than 25 percent in that time. The construction industry represents the fifth largest growth industry in Tehama County (9.4 percent); however, it does not rank in the top growth industries in Shasta County. The wholesale trade industry also represents the fourth and third growth industries in Shasta and Tehama counties, respectively, but growth rates are expected to be less than the State rate (U.S. Census Bureau 2011a).

Established businesses, along with new businesses that locate in the area, will play an important role in the expansion of the local economy, as projected by the State. Table 1-11 in the *Socioeconomics, Population, and Housing Technical Report* displays a number of the major employers in the primary study area. This list of employers includes a range of businesses with a payroll of more than 500 people. Three of the 10 businesses provide health care to local residents. Other employers with a payroll of over 500 people include: a wholesale nursery; insurance, pest management, and fuel management companies; a college; a manufacturer of industrial materials (mill work); and a wholesale distributor, identified as employing more than 1,000 people (EDD 2013a, 2013b).

Government and Finance Shasta and Tehama counties are the critical local governments in the primary study area. Each county has a primary urban center (Redding in Shasta County and Red Bluff in Tehama County), with a limited number of small cities and towns, and large amounts of rural land surrounding it. Because the two counties are largely rural, their total revenues and expenditures are relatively low when compared to other jurisdictions in California.

Revenues generated by Shasta County are used for a range of governmental activities. As described in the *Socioeconomics, Population, and Housing Technical Report*, expenditures increased from $302.8 million in the 2007 – 2008 fiscal year to $319.7 million in the 2008 – 2009 fiscal year. Expenditures decreased substantially in the 2009 – 2010 fiscal year to $309.6 million, as a result of decreased spending on transportation-related projects. Welfare, social services, and other public assistance have consistently been the largest expenditures for Shasta County (totaling more than $94.1 million in 2010), but remained relatively constant between 2007 and 2010. Police, fire, and other public safety activities represented the second largest expenditure category with more than $79.7 million in the 2009 – 2010 fiscal year.

Observed trends in Tehama County's revenues and expenditures have been generally similar to those experienced in Shasta County. Because of its smaller size, Tehama County's total revenues are substantially less than those of Shasta County ($112.3 million in the 2009 – 2010 fiscal year, compared to $309.6 million in Shasta County), but Tehama County experienced an overall decrease in revenue growth between 2007 and 2010.

Expenditures in Tehama County also are consistent with the trends observed in Shasta County.

Lower Sacramento River and Delta

Race/Ethnicity Overall, the majority of people in the nine-county lower Sacramento River and Delta portion of the extended study area are white (57.4 percent), but the proportion of population identified as white varies substantially between counties. In 2010, the white population of Glenn County (71.1 percent) was the highest proportion of any county in the area, while Sacramento and San Joaquin counties had the lowest proportion of white residents (51.0 percent) (U.S. Census Bureau 2010b). These proportions were less than that observed at the statewide level in 2010 (57.6 percent).

Income/Poverty Income and poverty characteristics for the lower Sacramento River and Delta area are similar to those for California as a whole. The median household income of the majority of counties within the nine-county area is similar to or higher than the statewide median household income ($59,641).

Poverty levels for both individuals and children in the lower Sacramento River and Delta counties are similar to the statewide level. Sacramento (16.6 percent), San Joaquin (17.7 percent), Glenn (18.2 percent), Yolo (19.9 percent), and Butte (20.3 percent) had higher overall poverty rates than California as a whole (15.5 percent) in 2010 (U.S. Census Bureau 2011b). The percentage of people below the poverty level is expected to follow national and statewide economic trends.

Employment and Labor Force Employment and labor trends in the nine lower Sacramento River and Delta counties generally are consistent with statewide trends. The area maintains a labor force of more than 1.9 million people, representing approximately 10 percent of California's labor force (18.3 million).

In the nine-county area in 2010, approximately 13.2 percent of the labor force was classified as unemployed, as compared to 12.4 percent statewide for the same period. Although the total unemployment rate was only 0.8 percent greater than the State's unemployment rate, unemployment within the lower Sacramento River and Delta counties varied substantially. Generally, the counties with the highest unemployment rates in 2010 had greater dependence on the agricultural industry and a reduced industrial diversity. Frequently, unemployment rates tend to be higher in rural areas than in urban areas, and farm workers commonly have seasonal and temporary jobs.

Business and Industry Business and industry in the lower Sacramento River and Delta counties are composed primarily of five sectors: government; educational and health services; professional and business services; retail trade; and leisure and hospitality (U.S. Census Bureau 2011b). These consistently rank in the top five sectors of the nine lower Sacramento River and Delta counties.

Government and Finance A total of 55 cities and towns and a range of special districts are located within the nine counties of the lower Sacramento River and Delta. This collection of governmental entities provides valuable public services to the lower Sacramento River and Delta area—education, fire protection, employment development, emergency services, and crime prevention and control. These agencies and special districts rely primarily on tax revenue disbursed by the State government, local sales and property taxes and fees, and the disbursement of Federal funds. This greater reliance on existing tax structures and rates, and a productive economic base, makes relatively reliable and affordable CVP and SWP water and power even more valuable, because its availability and affordability helps foster local business activity, and thus indirectly helps sustain the fiscal health of local service providers. Similarly, flood protection provided by Shasta Dam helps protect and sustain the appraised value of property within the dam's floodplain, again helping to protect the fiscal health of local service providers.

Total revenues and expenditures vary substantially between the nine counties of the lower Sacramento River and Delta because of the relative sizes of the counties and the services they provide. Revenues include payments received through taxes, licenses and permits, grants from other governments, charges for services, and others. Expenditures include payments made by a jurisdiction to buy goods, pay its employees, and provide services to its residents. Glenn County had the smallest total of revenues and expenditures, each at $82.2 million for 2009-2010, while Sacramento County had the greatest total of revenues and expenditures at $2.4 billion and $2.5 billion, respectively, for 2009-2010 (Glenn County 2009; Sacramento County 2009).

CVP/SWP Service Areas

Race/Ethnicity The population within the CVP and SWP service areas continues to diversify. The proportion of the statewide population made up of minority groups has been steadily increasing. The population of individuals in California who identify themselves as Asian–Pacific Islander or multiracial experienced double-digit population growth between 2000 and 2010 (U.S. Census Bureau 2002, 2010b). Hispanics are the largest minority population in California and many members of this ethnic group work on farms that receive some or all of their water from the CVP and SWP.

Income/Poverty Poverty levels for both individuals and children in California increased slightly between 2000 and 2010. The percentage of people below the poverty level is expected to follow national and statewide economic trends.

Employment and Labor Force Employment and labor force trends observed in the CVP and SWP service areas generally are synonymous with the trends observed at the statewide level because of the expanse of the CVP and SWP service areas. California's total labor force increased consistently from year to year between 2007 and 2010. Between 2007 and 2008, the labor force increased by approximately 282,100 individuals, which was the largest annual increase over the 4-year period. Between 2009 and 2010, the labor force increased by approximately 108,100 individuals. California's total labor force exceeded 18.3 million in 2010.

Although increases in the State's total labor force were relatively consistent, the State's unemployment rate fluctuated between 2007 and 2010. The State's unemployment rate was 5.4 percent in 2007 and increased steadily over the next 4 years to 12.4 percent. This increase in the unemployment rate at the State level coincided with similar national employment trends (EDD 2010a).

Business and Industry Business and industry trends for the CVP and SWP service areas are assumed to be equal to those at the statewide level because of the expanse of these service areas. The education and health services sector represents the largest industry in California, measured by total employees. Government is California's second largest work sector, and the retail trade, professional and business services, and leisure and hospitality industries all play important roles in the State's economy.

Government and Finance The State represents the most appropriate level of detail for the CVP and SWP service areas because of the expanse of the service areas and the interdependent nature of government and finance provision. California currently ranks as the seventh largest economy in the world and provides goods and services to more than 38 million people, making it the largest state in the nation. As a result, State government manages a large annual volume of revenues and expenditures. The State's adopted 2012–2013 budget includes a total of approximately $132.9 billion in revenues and transfers and $142.4 billion in total expenditures (State of California 2012). Many of the State's expenditures represent grants and other funding, made available to local jurisdictions throughout California. These funds may be used for a variety of services, such as health and human services, environmental protection, and resource management.

16.1.2 Population

Shasta Lake and Vicinity and Upper Sacramento River (Shasta Dam to Red Bluff)

The area surrounding Shasta Dam includes generally smaller cities and towns with two larger, primary urban areas in each of the two counties (Shasta County and Tehama County). Almost 39 percent of the population in Shasta County and more than 65 percent in Tehama County lived in unincorporated areas in 2010. By comparison, only 17.2 percent of the population in the entire State lived in unincorporated areas in 2010. In total, the populations of Shasta and Tehama counties make up less than 1 percent of the total population in California.

The cities of Redding and Red Bluff are the two largest urban areas in the primary study area. Redding, with a total of 91,561 residents in 2010, is the most populous city in the region. Red Bluff is the second largest city in the region and the largest city in Tehama County, with a total of 13,825 residents in 2010. Remaining cities within the primary study area – Anderson, Shasta Lake, and Tehama – all contained fewer than 11,000 residents in 2010.

Although Shasta and Tehama counties are still comparatively small, both counties have been growing substantially over the past 15-20 years. Since 1990, the population of Shasta County has increased by more than 25 percent. During that time, the populations of Redding and Anderson have increased by approximately 38 percent and 30 percent, respectively. A similar situation has been observed in Tehama County, where the total population has grown by more than 27 percent since 1990. Most of this new growth has occurred in the unincorporated areas of Tehama County, rather than in its cities.

Shasta and Tehama counties are expected to continue this growth trend, with substantial growth in Tehama County. The State of California projects that Shasta County's population will increase by 27 percent by 2050, to a total of approximately 233,500 residents (DOF 2012). This increase is less than that total expected at the statewide level (32.0 percent). Tehama County is expected to have a larger population increase compared to the state level, where the population is expected to increase approximately 44 percent between 2010 and 2050 (DOF 2012).

Lower Sacramento River and Delta

As described in the *Socioeconomics, Population, and Housing Technical Report*, roughly 4 million people live in the nine-county area that makes up the lower Sacramento River and Delta area (Butte, Colusa, Contra Costa, Glenn, Sacramento, San Joaquin, Solano, Sutter, and Yolo counties). This population represents approximately 11 percent of California's total population. Sacramento County and Contra Costa County are the two largest counties in the area, with approximately 1.4 million and 1.0 million residents, respectively, in 2010 (DOF 2010). All of the nine-county area is expected to grow at a faster rate than California as a whole (32.0 percent increase) through 2050. Population increases of at least 34 percent are expected in all nine counties in the area, over that time (DOF 2012).

CVP/SWP Service Areas

In 2010, California contained a total of 38.7 million residents. Approximately 80 percent of the State's population resided in the incorporated areas of its 58 counties (DOF 2010). Similar to the State as a whole, most of the population of the CVP and SWP service areas is concentrated within urban areas. Outside of these fast-growing population centers, most of the lands within the CVP and SWP service areas are rural, with irrigated agriculture being the predominant land use and driver of the local and regional economies.

California's population has increased by almost 25 percent since 1990, and it is projected to increase by approximately 32 percent to more than 51 million people by 2050. This substantial population increase will result in a sizeable increase in water and energy demand across the State. The proportion of the statewide population made up of minority groups has been steadily increasing.

16.1.3 Housing

Shasta Lake and Vicinity and Upper Sacramento River (Shasta Dam to Red Bluff)

As shown in the *Socioeconomics, Population, and Housing Technical Report*, as would be expected, provision of housing in the primary study area generally coincides with the population trends discussed above. Shasta County (77,857 units in 2010) maintains almost three times the amount of housing units as that of Tehama County (27,729 units) (DOF 2010). Of the nearby cities, Redding provides the largest supply of housing in the region, with more than 38,000 housing units. Redding's units represent roughly half the total housing units in Shasta County. Red Bluff provides the second largest housing stock in the area, with more than 6,000 units. Within Redding and Anderson, the increase in housing units between 1990 and 2010 was substantially greater than the percentage increase at the State level (21.5 percent). Redding observed the greatest increase in housing units since 1990 (40.9 percent).

Overall, single-family dwelling units are the predominant housing type in the primary study area. Vacancy rates generally were higher than the statewide average (5.9 percent), with the exception of Redding (5.0 percent) and Anderson (5.8 percent). Tehama County registered the highest vacancy rate in the primary study area, with 10.9 percent of all its housing units vacant. The average household size in jurisdictions of the primary study area ranged from as low as 2.33 persons per household (Tehama) to as high as 2.64 persons per household (Anderson and Shasta Lake). All of these totals were lower than the average number of persons per household at the statewide level (2.96 persons).

Lower Sacramento River and Delta

As shown in the *Socioeconomics, Population, and Housing Technical Report*, housing characteristics in the nine lower Sacramento River and Delta counties generally are similar to those at the statewide level. In 2010, the area contained approximately 1.6 million housing units. Similar to population, this total represents approximately 11 percent of California's housing stock (approximately 14 million houses). Overall, single-family housing makes up a larger proportion of the total housing stock in the nine-county area (72.7 percent) than recorded at the statewide level (64.4 percent) in 2010 (DOF 2010).

The vacancy rate in the nine-county area in 2010 was higher (5.3 percent) than the rate observed at the statewide level (4.8 percent). Vacancy in the majority of counties (six of nine counties) within the lower Sacramento River and Delta area was substantially lower than California as a whole (DOF 2010).

Average household size in the lower Sacramento River and Delta area is generally lower than that observed at the statewide level. In total, an average of 2.82 persons lived in the households of the nine-county area in 2010. This compared to an average of 2.96 persons for California as a whole (DOF 2010).

CVP/SWP Service Areas

A description of housing in the CVP and SWP service areas is not included because it would not be affected by the project.

16.2 Regulatory Framework

The analysis of socioeconomic resources is guided primarily by Federal laws and policies. State and local laws and policies typically promote economic development and diversity, environmental justice, public health and safety, and housing, and address the concerns of the residents within their jurisdictions. As noted in the following discussion, NEPA documents must include an assessment of potential conflicts with State and local plans and policies.

16.2.1 Federal

The major Federal laws and regulations guiding the assessment of socioeconomic resources are summarized below.

National Environmental Policy Act

Section 102 of NEPA requires Federal agencies to "insure the integrated use of the natural and social sciences" in planning and decision making (42 U.S. Code Section 4332).

Section 1502.16(c) of NEPA requires Federal agencies to identify potential conflicts between a proposed action and related plans and policies of Federal, State, and local agencies and Indian tribes. This requirement helps Federal agencies identify potential conflicts that may cause adverse effects on the social and economic environment of a study area because many agency and tribal plans and policies are designed to protect the people residing within their jurisdictions and/or the local economy they depend on for their economic livelihoods.

Council on Environmental Quality

The Council on Environmental Quality's "Regulations for Implementing the Procedural Provisions of NEPA" (40 Code of Federal Regulations (CFR) Sections 1500–1508) provide guidance related to social and economic impact assessment by noting that the "human environment" assessed under NEPA is to be "interpreted comprehensively" to include "the natural and physical environment and the relationship of people with that environment" (40 CFR 1508.14). Furthermore, these regulations require agencies to assess "aesthetic, historic, cultural, economic, social, or health" effects, whether direct, indirect, or cumulative (40 CFR 1508.8). Some Federal agencies, including the U.S. Bureau of Land Management and USFS, have developed socioeconomics-related handbooks and instructional memoranda to help EIS preparers comply with NEPA, with respect to socioeconomics resources.

Executive Order 12898 – Environmental Justice

In 1994, President Bill Clinton issued Executive Order 12898 regarding environmental justice. It requires Federal agencies to "identify and address" disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations in the United States. The Council on Environmental Quality issued guidance in 1997, to help Federal agencies incorporate environmental justice concerns into their NEPA procedures. Environmental justice issues are specifically addressed in Chapter 24, "Environmental Justice," of this EIS.

16.2.2 State

Most State and local governments have plans and policies intended to protect and expand local and regional economies affecting the communities and residents within their jurisdictions. Some of these plans and policies also are intended to promote public health and safety while minimizing conflicts between new development projects of all types; their associated traffic, air, and noise impacts; and the social environment within which local residents live and work. State plans and policies also frequently address other social and economic impact topics, including fiscal conditions and related public services that affect local residents' quality of life.

In California, the California Environmental Protection Agency adopted its own environmental justice policy in 2004. Pursuant to Sections 71110–71113 of the California Public Resources Code, the agency has developed this policy (or strategy) to provide guidance to its resource boards, departments, and offices. It is intended to help achieve the State's goal of "achieving fair treatment of people of all races, cultures and incomes with respect to the development, adoption, implementation and enforcement of environmental laws and policies."

16.2.3 Regional and Local

Each of California's counties, including Shasta and Tehama counties, has its own plans, ordinances, and other policies designed to protect and improve a wide range of socioeconomic conditions. Specifically addressed in these plans, ordinances, and policies are housing; employment opportunities for minorities and low-income populations, and others; economic diversification; and business activity in general.

Shasta County

Shasta County General Plan Two primary elements of the Shasta County General Plan (Shasta County 2004) address socioeconomic resources: Housing, and Economic Development. The Housing Element of the Shasta County General Plan (Shasta County 2011) establishes several goals and policies related to ensuring adequate housing provision, especially affordable housing, in the county. Shasta County's housing policies and programs are grouped into six primary categories, each supporting an identified goal. These categories and the goal associated with each are as follows:

- **Housing Supply**
  - **Goal –** To establish and implement policies and programs that will:
    - Contribute to the provision of an adequate supply and diversity of safe, healthy, and affordable housing for all income levels to meet the needs of residents in the unincorporated areas of Shasta County.

- Satisfy the requirements of the Regional Housing Needs Allocation Plan for Shasta County for the 2004-2009 Housing Element period, specifically to realize the construction of new units as follows: Very Low Income – 300 units; Low Income – 255 units; Moderate Income – 1,035 units; and Above Moderate Income – 810 units.

- **Conserve and Improve Existing Affordable Housing**

  - **Goal** – To conserve, improve, and expand the inventory of existing affordable housing stock in the incorporated areas of the County, specifically to realize the conservation and/or rehabilitation of the following units: Rehabilitation (150): 60 units – Very Low Income; 55 units – Low Income; 25 units – Moderate Income; and 10 units – Above Moderate Income; Conservation (150): 90 units – Very Low Income; 53 units – Low Income; and 7 units – Moderate Income.

- **Housing Development Constraints**

  - **Goal** – To continue to remove all County constraints, as is practical and legal, which have the potential to hinder or impede the development of affordable housing projects.

- **Special Needs**

  - **Goal** – To continue to work collectively with local agencies to enhance and expand the outreach programs designed to provide accessible and affordable housing, including supportive services, for those persons with special needs including the elderly, large families, single mothers, children, developmentally and physically disabled persons, the mentally ill, farmworkers, and the homeless.

- **Energy Conservation**

  - **Goal** – To explore, implement, and promote energy conservation practices in all eligible existing and new housing projects.

- **Fair Housing**

  - **Goal** – To continue to use all feasible means to promote, expand, and ensure equal access to available, safe, decent, affordable housing opportunities in the unincorporated area without bias or prejudice for any reason for all economic segments of the County.

The Economic Development Element of the Shasta County General Plan (Shasta County 2004) establishes the following two overall objectives for economic development:

- **ED-1 –** Economic development plans, programs, and policies shall contribute to a stable and healthy economy in Shasta County, which includes provision of a land development pattern, planning process, and regulatory atmosphere conducive to maintaining employment opportunities for County residents and fostering new economic development.

- **ED-2 –** Seek economic diversity that increases the variety, type and scale of business, industrial, and manufacturing activities.

To support these objectives, Shasta County has established three primary policies for implementation. These policies emphasize the reuse and revitalization of existing development and full use of existing infrastructure for new business opportunities. To attract business to Shasta County, a number of incentive programs are employed, including community development block grants, economic assistance through a county redevelopment agency, and business development and retention assistance through an economic development corporation. Additionally, a 50-square-mile, State-defined enterprise zone (one of only 39 in California) has been designated in portions of Redding, Shasta Lake, Anderson, and unincorporated Shasta County. Enterprise zones are generally designated in locations characterized by high poverty rates. Businesses locating within these areas may receive State-supported incentives, such as sales and use tax credits, hiring assistance tax credits, and special business expense deductions (Shasta County 2004).

Tehama County

In the Tehama County General Plan, updated in 2009 (Tehama County 2009), Tehama County set out three “fundamental concepts” that relate to population growth and demographic shifts: (1) accommodating growth, but not limiting growth or accepting uncontrolled growth; (2) locating major growth along the Interstate 5 transportation corridor; and (3) organizing growth according to a range of community types. These concepts emphasize where Tehama County expects to locate new growth and how they plan to accommodate it. Specifically, the Interstate 5 corridor plays a significant role for the placement of new development, and Tehama County attempts to provide a range of housing types for the diversity of needs created within the community. This emphasis on housing diversity may become more crucial as aging residents’ housing preferences change.

The following housing-related goals in the general plan are relevant to the project:

- **Goal HE-3: Adequate Sites –** Ensure the provision of adequate sites and facilities to support future housing needs.

- **Goal HE-5: Housing Conservation –** Work to improve, maintain and conserve the County’s existing housing stock.

- **Goal HE-6: Addressing Constraints –** Address and wherever possible remove, governmental constraints to the maintenance, improvement, or development of housing to meet the needs of County residents.

- **Goal HE-7: Fair Housing/Equal Opportunity –** Promote equal housing opportunities for all persons without discrimination regardless of age, race, sex, marital status, ethnic background, household composition, sources of income, or other arbitrary factors.

Relevant economic development-related goals contained in the draft general plan are as follows:

- **Goal ED-3 –** Expand the economic base while maintaining a healthy and diverse local economy that meets the present and future employment, shopping, recreational, public safety, and service needs of Tehama County residents.

- **Goal ED-4 –** Work toward providing adequate infrastructure to support commercial, industrial, and recreational development within Tehama County including clean-up of contaminated industrial sites.

- **Goal ED-7 –** Protect and enhance environmentally sensitive lands and natural resources while, at the same time, promoting business expansion, retention, and recruitment.

Shasta and Tehama counties function as the primary agencies responsible for implementing policies and programs aimed at addressing employment and labor force issues within the project's primary study area.

16.3 Environmental Consequences and Mitigation Measures

Based on the review of the affected environment provided in Section 16.1 of this chapter, this section describes the potential environmental consequences resulting from each of the proposed alternatives. Direct, indirect, and cumulative effects of the alternatives are discussed below. When potential environmental consequences are identified, specific mitigation measures to offset the potential effects of the alternatives are presented. Potential effects and mitigation measures address topics related to population, demographics, and housing; employment and labor force; business and industry; and government and finance.

16.3.1 Methods and Assumptions

Population, Housing, and Demographics

The analysis of the potential impacts of the project alternatives on population, housing, and demographic characteristics was based on a review of published material pertaining to the primary and extended study areas. California Department of Finance population and demographics databases and projections, U.S. Census Bureau population and demographics data, the general plans of jurisdictions within the study areas, and other similar source documents were reviewed.

Population effects were evaluated based on changes in the total number of temporary and/or permanent residents likely to result from construction and operations activities that would be performed as part of project implementation. Housing effects were assessed based on estimated short- and long-term housing needs resulting from population changes, expected as a result of the project's construction and operational activities. Effects of the project on local and regional demographic characteristics were assessed quantitatively, when available data allowed. When quantitative analysis of effects was not possible at this broader geographic level, qualitative effects were identified based on the projected makeup (e.g., ethnicity, economic class) of any population changes expected to result from project implementation.

Employment and Labor Force

The determination of potential impacts on employment and the labor force was based on a review of relevant information related to current conditions. Documents such as the California Employment Development Department's employment and labor force databases, the Economic Development and Housing elements of the Shasta County General Plan (2004), and the Tehama County General Plan Update (2009) were reviewed, along with estimates of employment (temporary and permanent jobs created) for each proposed alternative.

To quantify the potential job creation resulting from each proposed alternative, IMPLAN (IMpact analysis for PLANning model, Version 3.0.17.2) modeling was performed. IMPLAN modeling uses a branch of economics known as Input/Output analysis originally developed from the analytical work conducted by Wassily Leontief in the late 1930s. Input/Output models are essentially accounting tables that trace the linkages of interindustry purchases and sales within a specific region, and within a given year. The Input/Output model yields "multipliers" that are used to calculate the total direct, indirect, and induced effects on jobs, income, and output generated per dollar of spending on various types of goods and services in the local economic study area. IMPLAN was originally developed by the USFS and now is maintained and marketed by the Minnesota IMPLAN Group, Inc.

The IMPLAN modeling incorporated project construction-related economic activity in the four-county region surrounding Shasta Lake. The primary set of effects analyzed using the regional model was how project construction would affect output, personal income, and employment within the four-county area containing the dam and reservoir. The project costs and duration over which construction activity would take place were developed for each action alternative. The costs were organized into categories to assess the required investment that would take place in certain primary sectors of the local economy, namely concrete- and steel-related manufacturing, rock and aggregate, and dam and non-residential construction.

Several specific assumptions were necessary to complete IMPLAN modeling of the project. The following assumptions were used:

- IMPLAN modeling was completed for CP1 (which involves raising Shasta Dam by 6.5 feet); CP2 (which involves raising the dam by 12.5 feet); and CP3, CP4, CP4A, and CP5 (all of which involve raising the dam by 18.5 feet).

- A construction period of approximately 4.5 years was assumed under CP1, and 5 years under CP2, CP3, CP4, CP4A, and CP5.

- The "local economic study area" was defined as the four-county area of Shasta, Siskiyou, Tehama, and Trinity counties.

- A total labor force of 300 construction workers would be needed for CP1 and CP2; 350 construction workers would be needed for CP3, CP4, and CP4A; and 360 construction workers would be needed for CP5.

- All 300–360 construction workers would be drawn directly from the local economic study area (used in IMPLAN modeling). (High unemployment in the primary study area and the availability of necessary worker skill sets supports this assumption.)

In addition to IMPLAN modeling, the Statewide Agricultural Production (SWAP) model, Version 6, was used to determine the effects of the action alternatives on CVP and SWP agricultural users. The SWAP model is a regional economic model of irrigated agricultural production that simulates the decisions of agricultural producers (farmers) in the Central Valley of California. The model included 27 crop production regions in the Central Valley and 20 categories of crops. Based on the changes in water availability expected with each alternative, the SWAP model predicted cropping patterns, land use, and water use in the Central Valley. These predictions then were used to calculate expected changes in net income resulting from each alternative during dry, wet, and average water years.[1] Although the model's income-related projections were generally used to determine effects on business and industrial activity, the overall change in business net income (or profits) is a good indicator for potential changes in employment opportunities in affected sectors.

[1] Throughout this document, water year types are defined according to the Sacramento Valley Index Water Year Hydrologic Classification unless specified otherwise.

Additional information on methods and assumptions for the IMPLAN and SWAP models is provided in the Modeling Appendix.

Business and Industry

The discussion of potential impacts on business and industry is based on a review of relevant information on current conditions, specifically California Employment Development Department documents, the Economic Development Element of the Shasta County General Plan (2004), the Tehama County General Plan Update (2009), and estimates of business and industry effects for each action alternative.

To quantify the potential effect on job creation and personal incomes resulting from each action alternative, IMPLAN modeling was completed by Reclamation economists. A description of IMPLAN modeling, generally, and the specific assumptions used, related to the project, are provided in the previous section.

Government and Finance

The determination and discussion of potential impacts on government and finance was based on a review of relevant information on existing conditions, specifically the Economic Development Element of the Shasta County General Plan (2004), the Tehama County General Plan Update (2009), and estimates of local government and finance effects for each dam-raise alternative.

Because no quantitative analysis of the effect of the action alternatives on local government and finance has been completed yet, this analysis depends heavily on a qualitative discussion of potential impacts. Areas of potential impacts were identified by comparing existing conditions and probable future conditions. In many cases, the estimates completed as part of the IMPLAN and SWAP modeling served as the basis for impact estimates. These two models determine expected trends in employment, personal incomes, business incomes, agricultural production, and other data types to quantifiably estimate the impacts of the proposed alternatives. Because these local characteristics directly influence activities at the local level, they represent critical considerations in the analysis and conclusions presented in this section.

16.3.2 Criteria for Determining Significance of Effects

An environmental document prepared to comply with NEPA must consider the context and intensity of the environmental effects that would be caused by, or result from, the proposed action. Under NEPA, the significance of an effect is used solely to determine whether an EIS must be prepared. An environmental document prepared to comply with CEQA must identify the potentially significant environmental effects of a proposed project. A "[s]ignificant effect on the environment means a substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by the project" (State CEQA Guidelines, Section 15382). CEQA also requires that the environmental document propose feasible measures to avoid or substantially reduce significant environmental effects (State CEQA Guidelines, Section 15126.4(a)).

The following significance criteria were developed based on guidance provided by the State CEQA Guidelines, and consider the context and intensity of the environmental effects as required under NEPA. Impacts of an alternative on socioeconomics, population, and housing would be significant if project implementation would do any of the following:

- Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure)
- Displace substantial numbers of people or housing, necessitating the construction of replacement housing elsewhere
- Produce a substantial burden on the existing housing stock within the local community because of an increased housing demand created by nonlocal project employees
- Require sizeable numbers of new workers in a particular industrial sector from outside the local area during construction or operation for effective implementation
- Substantially increase the risk of housing or other property damage caused by flooding
- Cause a substantial decrease in the number of opportunities for temporary or long-term direct employment within the primary study area or the extended study area (within Shasta County, Tehama County, or nearby cities and towns, specifically Redding, Anderson, Shasta Lake, and Red Bluff)
- Compete with established industries for workers within the labor force or associated resources to the extent that a shortage of workers available to related businesses would exist
- Cause a substantial decrease in the number of opportunities for temporary or long-term increases in personal and/or disposable incomes within the primary or extended study area (within Shasta County, Tehama County, or nearby cities and towns, specifically Redding, Anderson, Shasta Lake, and Red Bluff)
- Considerably decrease the sales and/or incomes of businesses in the primary or extended study areas

Significance statements are relative to both existing conditions (2005) and future conditions (2030), unless stated otherwise.

16.3.3 Topics Eliminated from Further Discussion

In contrast to the primary study area and the lower Sacramento River and Delta portion of the extended study area, additional flood control capacity provided by the action alternatives is not expected to substantially affect the CVP and SWP service areas beyond the lower Sacramento River and Delta. Dam operations (i.e., storage and release scenarios) in the CVP and SWP service areas are expected to continue, according to management plans similar to those currently in place. Therefore, no flood-related impact on population and housing would occur in the CVP and SWP service areas. This topic is not discussed further under CP1–CP5.

16.3.4 Direct and Indirect Effects

Similar to the approach used in Section 16.1, "Affected Environment," the following discussion of environmental consequences in the primary study area does not separate Shasta Lake and vicinity from the upper Sacramento River (Shasta Dam to Red Bluff) because of the regional interdependence of their socioeconomic characteristics. Instead, environmental consequences are discussed for the entire primary study area and the two counties that encompass it, Shasta and Tehama counties.

No-Action Alternative

Under the No-Action Alternative, no additional Federal action would be taken to address water reliability issues or increase anadromous fish survival. Therefore, Shasta Dam and Shasta Lake would continue to operate as they currently do, with some modifications (currently not known) expected in the future. With the No-Action Alternative, water reliability is expected to become an increasing issue as demand for water increases to meet the needs of California's growing population. Over time, water conservation and reuse efforts would increase, and water provision is expected to shift from such areas as agricultural production to urban uses. Environmental restoration, flood control, and hydropower generation are expected to continue similar to existing conditions. Like water demand, electricity demand in California is expected to increase substantially in the future. This increased demand is expected to create localized shortages in energy availability over time.

Shasta Lake and Vicinity and Upper Sacramento River (Shasta Dam to Red Bluff) Under the No-Action Alternative, population, demographics, and housing conditions are expected to continue following the current growth trends described in Section 16.1, "Affected Environment." The projected employment and labor force characteristics summarized in Section 16.1 also would continue. The relatively large number of new construction-related jobs that would be created by all of the action alternatives would not be created. Therefore, this alternative would have no impact on population and housing or on employment and the labor force.

In addition, the business and industrial activity in the primary study area would continue, as summarized in Section 16.1, “Affected Environment.” The relatively large and temporary increase in business activity that would occur during project construction would not occur. Therefore, the No-Action Alternative would have no impact on business and industrial activity.

Furthermore, the local government and finance conditions and trends, projected in Section 16.1, “Affected Environment,” would continue because new facilities would not be constructed and existing facilities would not be altered, expanded, or demolished. The positive fiscal effects associated with the increase in sales and income tax revenue from construction-related spending would not occur. Therefore, the No-Action Alternative would have no impact on government and finance.

Lower Sacramento River and Delta Under the No-Action Alternative, the projected population, demographics, and housing conditions as well as development conditions, described in Section 16.1, “Affected Environment,” would remain unchanged. No impact on population, demographics, or housing would occur.

In addition, the local government and finance conditions, described in Section 16.1, “Affected Environment,” would continue because no new facilities would be constructed and no existing facilities would be altered, expanded, or demolished. The positive fiscal effects associated with the increase in sales and income tax revenue resulting from project construction-related spending would not occur. Therefore, the No-Action Alternative would have no impact on government and finance.

The impacts of the No-Action Alternative on employment and the labor force and on business and industrial activity in the lower Sacramento River and Delta area are described below.

Impact Socio-1 (No-Action): Potential for Reduced Employment Opportunities for Lower Sacramento River and Delta Area Residents The No-Action Alternative has the potential to result in periodic water and power supply disruptions from increasing demand on the existing supply caused by population growth. These disruptions could result in adverse economic effects on the lower Sacramento River and Delta portion of the extended study area. This impact would be potentially significant.

Under the No-Action Alternative, the risk of CVP and SWP water supply disruptions as well as Western Area Power Administration and DWR power supply disruptions in the lower Sacramento River and Delta area would be higher than the risk of such disruptions in the long term under the action alternatives. Although the likelihood of such disruptions is difficult to predict, the CalSim-II Version) modeling performed to simulate future water and power supply conditions under 2030 No-Action Alternative conditions, and 2030 conditions under each of the action alternatives, indicates that all of the action alternatives would enhance CVP and SWP water and power supply conditions relative to 2030 No-Action Alternative conditions. (CalSim-II modeling of power supply conditions for the 2030 No-Action Alternative currently is not available.)

An increase in the risk of water and power supply disruptions could, in turn, increase the likelihood that temporary and adverse socioeconomic effects would take place during related reductions in economic activity, including reductions in employment opportunities. Adverse economic effects during times of drought, blackouts, or other types of water or power supply disruptions also could include delays in hiring employees or layoffs, if businesses experience water and/or power rate increases as a result of water and power purveyors seeking other, more expensive replacement sources. This impact would be potentially significant. Mitigation is not required for the No-Action Alternative.

Impact Socio-2 (No-Action): Potential for Temporary Disruptions in Business and Industrial Activity in the Lower Sacramento River and Delta Area If water or power supply disruptions were to occur, they could cause temporary reductions in business and industrial activity, especially where water- and power-intensive industries and businesses are found. This impact would be potentially significant.

As discussed under Impact Socio-1 (No-Action) above, an increase in the risk of water or power supply disruptions could occur in the lower Sacramento River and Delta portion of the extended study area under the No-Action Alternative. If such disruptions were to occur, they could cause temporary reductions in business and industrial activity, especially in areas where water- and power-intensive industries and businesses are found. Because the No-Action Alternative could have adverse effects on businesses and industrial activity in the case of drought, blackouts, or other types of water or power supply disruptions, this impact would be potentially significant. Mitigation is not required for the No-Action Alternative.

CVP/SWP Service Areas Under the No-Action Alternative, the projected population, demographic, and housing conditions as well as development conditions, described in Section 16.1, “Affected Environment,” would remain unchanged. No impact would occur. Therefore, potential effects of the No-Action Alternative on population, demographics, or housing in this geographic region are not discussed further.

In addition, the local government and finance conditions in the CVP and SWP service areas described in Section 16.1, “Affected Environment,” would continue. The positive fiscal effects associated with the increase in sales and income tax revenue resulting from construction-related spending would not occur. Therefore, no impact would occur under the No-Action Alternative.

Potential effects of this alternative on government and finance in this geographic region are not discussed further.

The impacts of the No-Action Alternative on employment and the labor force and on business and industrial activity in the CVP and SWP service areas are described below.

Impact Socio-3 (No-Action): Potential for Reduced Employment Opportunities for Residents within the CVP and SWP Service Areas The No-Action Alternative has the potential to result in periodic water and power supply disruptions from increasing demand on the existing supply, caused by population growth. These disruptions could result in variability in economic activity, which could reduce or delay employment opportunities in the CVP and SWP service areas. This impact would be potentially significant.

Under the No-Action Alternative, the risk of CVP and SWP water supply disruptions as well as Western Area Power Administration and DWR power supply disruptions would be higher than the risk of such disruptions in the long term under each of the action alternatives. The likelihood of such disruptions is difficult to predict; however, the CalSim-II modeling performed to simulate future water and power supply conditions under 2030 No-Action Alternative conditions, and 2030 conditions under each of the action alternatives, indicates that all of the action alternatives would enhance CVP and SWP water and power supply conditions relative to 2030 No-Action Alternative conditions. (CalSim-II modeling of power supply conditions for the 2030 No-Action Alternative currently is not available.)

An increase in the risk of water and power supply disruptions, including drought, blackouts, or other types of water or power disruptions, could in turn increase the likelihood of temporary and adverse socioeconomic effects. Adverse economic effects during times of these disruptions could reduce economic activity and also result in delays in hiring employees or layoffs if businesses were to experience water and/or power rate increases as a result of water and power purveyors seeking other, more expensive replacement sources. This impact would be potentially significant. Mitigation is not required for the No-Action Alternative.

Impact Socio-4 (No-Action): Potential for Temporary Disruptions in Business and Industrial Activity in the CVP and SWP Service Areas If water or power supply disruptions were to occur, they could cause temporary reductions in business and industrial activity, especially where water- and power-intensive industries and businesses are found. This impact would be potentially significant.

As discussed under Impact Socio-3 (No-Action) above, an increase in the risk of water or power supply disruptions could occur in the CVP and SWP service areas under the No-Action Alternative. If such disruptions were to occur, they could cause temporary reductions in some business and industrial activity, especially in areas where water- and power-intensive industries and businesses are found. Because the No-Action Alternative could have adverse effects on businesses and industrial activity in the case of drought, blackouts, or other types of water or power supply disruptions, this impact would be potentially significant. Mitigation is not required for the No-Action Alternative.

CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

CP1 focuses on increasing water supply reliability and increasing anadromous fish survival. This plan primarily consists of raising Shasta Dam by 6.5 feet, which, in combination with spillway modifications, would increase the height of the reservoir's full pool by 8.5 feet and enlarge the total storage capacity in the reservoir by 256,000 acre-feet to 4.81 million acre-feet (MAF). CP1 would increase the maximum surface area of the pool to 30,800 acres. Shasta Dam operational guidelines would continue essentially unchanged, except during dry years and critical years, when 70,000 acre-feet and 35,000 acre-feet, respectively, of the increased storage capacity in Shasta Reservoir would be reserved to specifically focus on increasing municipal and industrial (M&I) deliveries.

Implementing CP1 is expected to result in the replacement or modification of 8 bridges and relocation of approximately 45 existing structures. The total construction cost associated with CP1 would be approximately $990 million.

CP1 would help reduce estimated future agricultural and M&I water shortages and would increase water supply reliability in the CVP/SWP service areas by increasing water supplies for agricultural and M&I deliveries, by at least 47,300 acre-feet per year in dry and critical years, and increasing average annual deliveries by about 31,000 acre-feet per year. The majority of the increased dry and critical year water supplies (i.e., 42,700 acre-feet) would be for south-of-Delta agricultural and M&I deliveries. In addition, CP1 would provide hydropower benefits by increasing hydropower generation, by approximately 54 gigawatt-hours (GWh) per year. In addition, the increased depth and volume of the cold-water pool in Shasta Reservoir would contribute to improving seasonal water temperatures for anadromous fish in the upper Sacramento River.

Shasta Lake and Vicinity and Upper Sacramento River (Shasta Dam to Red Bluff)

Impact Socio-1 (CP1): Short-Term Increase in Population and Housing Demand in the Primary Study Area Resulting from Construction-Related Activities According to Reclamation estimates, approximately 300 direct jobs would be created as a result of construction activities associated with CP1. All 300 construction workers are expected to come from the local labor force; therefore, a temporary population increase is not expected. This impact would be less than significant.

Approximately 300 construction workers would be needed over the 4.5-year construction period to support the construction activities related to the 6.5-foot raise of Shasta Dam. Because of the availability, experience, and expertise of the existing labor force within the primary study area, the necessary workers are expected to be available in the surrounding two counties (Shasta and Tehama counties). Therefore, no construction workers are expected to be sourced from outside the primary study area, and no employees (or very few) would need to relocate to the project area during the construction period. Even if a relatively small number of workers were to come from outside the local area, sufficient housing capacity (e.g., rental housing, motel, and apartment vacancies) exists in the area. Thus, effects on population and housing in the primary and extended study areas are not expected; if they were to occur, they would be very minor. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-2 (CP1): Short-Term Increases in Direct, Indirect, and Induced Employment in the Primary Study Area Related to Construction Activities
Construction activities associated with CP1 would generate approximately 300 construction jobs, 400 indirect jobs in various construction-related support industries, and 610 induced jobs because of increased household spending in the primary study area. Individuals to fill these jobs are expected to be drawn from the local community. These new jobs are expected to provide important but temporary employment opportunities to many unemployed construction workers in the primary study area. This impact would be beneficial.

Concrete workers, workers with large-scale construction experience, general laborers, and others would be drawn from the existing local construction industry. These jobs would represent a relatively small increase (less than 0.3 percent) in the total labor force in the two counties (109,960 employees) of the primary study area, but would represent a substantial increase in employment for many of the cities surrounding the project site, where employment has consistently been below countywide and statewide averages (EDD 2010a, 2010b).

Although the increase in employment would represent a small percentage increase for the two-county area, the employment opportunities created by CP1 would represent a substantial contribution in counties that have consistently registered high unemployment rates. Unemployment rates steadily increased in both Shasta and Tehama counties, from around 7 percent in 2007 to over 15 percent in 2010 (EDD 2010a). Similarly, unemployment rates in the cities of Anderson, Shasta Lake, and Red Bluff steadily increased between 2007 and 2010, with Anderson and Shasta Lake exceeding those recorded at both county levels (EDD 2010b). Within Trinity and Siskiyou counties (i.e., the remaining two counties in the local economic study area, the area used in IMPLAN modeling), the 2010 unemployment rates exceeded 16 percent and 18 percent, respectively (EDD 2010c).

As stated above, IMPLAN modeling calculates “direct” employment generated by individual alternatives as well as “indirect and induced” positions that are created by construction-related and operational activities. Indirect employment may be to support hiring in businesses that provide materials to the construction effort; in service-related industries that provide food, beverages, and other goods to construction workers; or in more technical industries, such as consulting firms and other businesses. Induced employment is jobs that are created in the region because of increased household spending and not limited to construction-related activities.

In addition to the 300 direct, construction-related jobs to be created from CP1, an additional 400 indirect jobs are expected to be created from construction support industries, and 610 induced jobs from increased household spending near the project area. The generation of 1,320 new positions (direct, indirect, and induced) would represent a 1.0 percent increase from the total 2010 labor force of the four counties in the local economic study area used in the IMPLAN modeling (Shasta, Tehama, Trinity, and Siskiyou counties), which totaled approximately 135,100 employees (EDD 2010c). A 1.0 percent increase in employment would represent a substantial increase in total employment, especially for an area experiencing unemployment rates like those observed in the primary study area.

Because CP1 would create direct, indirect, and induced jobs in an area with high unemployment rates, this impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-3 (CP1): Potential for Temporary Reduction in the Labor Force of Related Industrial Sectors in the Primary Study Area as a Result of Direct Construction-Related Employment With the creation of 300 construction jobs resulting from CP1, the potential would exist for workers from other industries to move to jobs related to construction at Shasta Dam. Because of the size of the construction industry in the primary study area, and the high unemployment rate in the area, this impact would be less than significant.

As the 300 positions created under CP1 are filled, the potential would exist for the positions to be filled by individuals currently working in related industries within the local community. This transfer of workers from related industries to the Shasta project could create a labor shortage in the related industry, if particularly skilled workers are required. In 2010, Shasta County registered 4,700 employees in the construction industry, while construction industry workers in Tehama County equaled only 1,600 individuals, for a total of 6,300 construction workers in the area (U.S. Census Bureau 2011a). Based on total employment levels and current unemployment trends in the primary study area, the 300 new construction-related jobs are not expected to substantially affect the local labor force. If a high number of workers were to be sourced from Tehama County, a limited effect could be observed because of the small number of workers in the construction industry in that county. Overall, however, this

impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-4 (CP1): Short-Term Increases in Direct, Indirect, and Induced Personal Income Paid to Employees in the Primary Study Area Hired for Construction-Related Activities Based on calculations completed as a part of the IMPLAN socioeconomic model process, more than $85.9 million in personal income is expected to be directly paid to employees in the primary study area each year of construction under CP1. In addition, more than $48.3 million in personal income is expected to be generated from various indirect and induced construction-related and other industries in the primary study area each year of construction under CP1. The combined $134.2 million in personal income to be generated would represent an approximately 92 percent increase in all annual personal income in the local economic study area. This impact would be beneficial.

Based on the results of modeling that was performed using the IMPLAN model, an estimated $85.9 million would be directly paid each year to the approximately 300 construction workers required to complete work for CP1during the proposed 4.5-year construction period. The positions expected from implementation of project construction are anticipated to be union positions, and workers would be paid according to union wage and benefit standards.

Based on the generation of 1,010 indirect and induced jobs resulting from implementation of CP1, $48.3 million in personal income is expected to be available for residents of the local economic study area each year during the proposed 4.5-year construction period. This personal income would be generated in industries that would support the construction efforts at Shasta Dam.

Personal income in the four counties of the local economic study area has substantially decreased, from $8.9 billion in 2007 to $9.8 million in 2010 (EDD 2010d). Most of this decline can be attributed to high unemployment rates and other recessionary factors. With more than $6.2 million in personal income in 2010, Shasta County contributed more than 60 percent of personal income in the four counties.

The combined direct, indirect, and induced personal income resulting from CP1 is expected to exceed $134.2 million per year of construction activities within the local economic study area. This increase in personal income would represent an approximately 92 percent increase in all annual personal income in the local economic study area. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-5 (CP1): Short-Term Increases in Sales and Profits for Businesses in the Primary Study Area that Support the Construction Industry Most of the construction materials used for CP1 are expected to be purchased within the primary study area. These purchases would provide the local economy with increased sales and profits over the 4.5-year construction period. This impact would be beneficial.

A large amount of construction material would be needed to raise Shasta Dam by 6.5 feet, as prescribed in CP1. These purchases may include raw or refined materials, infrastructure-related products, and/or equipment required for the construction process. Most of this material likely would be sourced from businesses within the primary study area. As a result of the large quantity of purchases expected, local businesses would experience temporary increases in sales and profits over the 4.5-year construction period. During the construction period, implementation of CP1 is expected to generate more than $349.8 million per year in sales and profits for construction-related and service-oriented businesses that support the construction industry, with approximately $220.0 million in direct income and $129.8 in indirect and induced income. Increased sales and profits could be reinvested into existing businesses, invested in new ventures or diversification, translated into increased salaries and wages for employees, or used in other ways. Therefore, this impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-6 (CP1): Short-Term Increase in State and Local Sales Tax Revenues in the Primary Study Area from Construction-Related Personal Income and Purchases As stated above, implementation of CP1 is expected to result in a substantial increase in total personal income (direct, indirect, and induced) during the construction period. This additional income, in combination with the construction-related purchases in the primary study area, would result in a substantial increase in local sales tax revenues from increased consumer spending in nearby cities and counties. Construction-related activities under CP1 likely also would result in a temporary increase in State sales and income tax revenues received from businesses and residents of the primary study area. The exact amount of State and local sales tax revenue increases would be speculative; however, this impact would be beneficial.

Based on the results of modeling performed using the IMPLAN model, implementation of CP1 is expected to generate more than $603.8 million in total personal income, with approximately $386.5 million in direct income and $217.4 million in indirect and induced income during the proposed 4.5-year construction period (see Impact Socio-4 (CP1), above). In addition to this increase in personal income, most of the construction materials would be purchased within the primary study area, generating a substantial amount of revenue and profits for local businesses (see Impact Socio-5 (CP1), above).

In combination, increased personal income and construction-related spending are expected to substantially increase the total sales tax revenues of local jurisdictions within the primary study area. Larger amounts of local sales tax revenue then could be used to establish new programs and initiatives or bolster existing ones through additional funding. New and improved programs and initiatives would provide benefits to local residents.

As a result of the increased employment and personal income anticipated from implementation of CP1, a temporary increase in State sales and income tax would be likely to occur. During the construction period, more than $603.8 million in personal income is expected to be generated by direct, indirect, and induced employment, produced by the project. The increase in personal income would increase spending at local businesses within the primary study area. The exact amount of State and local sales tax revenue increases would be speculative; however, this additional spending would result in sizeable State sales tax revenues. This increased revenue source would be likely to return to the primary study area via statewide programs and policies.

For the reasons described above, this impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-7 (CP1): Long-Term Reduction in the Adverse Economic Effects of Flooding in the Primary Study Area As a result of the added reservoir capacity created by CP1, the overall risk of flooding below Shasta Dam and its related consequences to the primary study area are expected to be reduced. Although heavy rain events would continue to occur in the region and locally, the project is intended to provide greater flexibility in flood control downstream because of the increased capacity of the reservoir. As a result, less damage to existing structures and a smaller loss of potential future development would occur; this, in turn, would reduce salary and wage losses for residents of the primary study area, as well as business and personal income losses from such damage. Therefore, this impact would be beneficial.

In Reclamation’s Initial Alternatives Information Report (2004), flood control was identified as a secondary objective of the project. Increased flood control is to be emphasized when the two primary objectives of the project, increased anadromous fish survival and increased water supply reliability, can be met. Periodic flood events in the Sacramento Valley frequently cause substantial damage to properties adjacent to the valley’s many waterways. Currently, Shasta Dam provides substantial protection from such flooding damage for downstream residents.

CP1 would increase the storage capacity of Shasta Lake by 256,000 acre-feet. This added capacity would provide greater flexibility in Reclamation’s ability to use the reservoir for flood control purposes, thereby increasing the threshold at which seasonal heavy rain events produce flood conditions downstream from the dam. The benefits of this increase in capacity and related flood control options would be most evident along the upper Sacramento River within the primary study area. Structures and inhabitants in this floodplain experience the most direct effects from storage releases during flood events. CP1 would reduce the frequency, magnitude, and duration of future flood events that have affected structures and their residents in this part of the primary study area in the past.

The loss of jobs and adverse effects on economic well-being and livelihoods is an often overlooked consequence of catastrophic flood events. Avoiding a larger number of these events, and possibly decreasing the magnitude and duration of flooding under certain high-flow events, is expected to reduce the overall economic hardships faced by residents of the primary study area under CP1.

Structures and businesses located on the river and inhabitants of the floodplain experience the most direct effects from flood releases downstream. However, flood events also could affect those not living on the river or in the floodplain but working downstream from the dam at businesses subject to flood damage. The reduced risk of flood events associated with CP1 also is expected to reduce the business and personal income losses resulting from substantial damage to structures and businesses located adjacent to downstream waterways in the primary study area.

Implementation of CP1 would reduce damage to structures, loss of business and personal income, loss of jobs, and other adverse effects on economic well-being in the primary study area. Therefore, this impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-8 (CP1): Long-Term Increases in Direct Employment in the Primary Study Area Related to Project Operations In the long term, implementation of CP1 is expected to create at least two new maintenance-related positions at the Shasta Dam facilities. These two positions are expected to be permanent and would continue once the 4.5-year construction period is completed. This impact would be minor but beneficial.

Reclamation estimates that with the 6.5-foot increase of Shasta Dam proposed in CP1, at least two new permanent maintenance positions would be required to ensure efficient operation of dam facilities. These two positions are expected to be union positions, and consequently would provide union-level wages and benefits. Both positions would be filled after completion of the construction activities associated with CP1 and would continue for the foreseeable future. This impact, though small, would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta

Impact Socio-9 (CP1): Potential Temporary Increase in Indirect Employment in Construction-Related Businesses of the Lower Sacramento River and Delta Construction activities associated with CP1 have the potential to result in a temporary increase in indirect employment within the lower Sacramento River and Delta portion of the extended study area. Depending on the location of construction materials sourced outside of the primary study area, indirect increases in employment within construction-related businesses may result in the lower Sacramento River and Delta area. This impact would be minor but beneficial.

As a result of construction activities that would be completed during implementation of CP1, temporary increases in indirect employment would be expected in the lower Sacramento River and Delta portion of the extended study area. A small amount of the construction materials necessary for CP1 would be obtained outside the primary study area. During the construction period, businesses that provide construction materials are expected to increase employment to meet project demand. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-10 (CP1): Short-Term Increases in Sales and Profits for Businesses in the Lower Sacramento River and Delta Area that Support the Construction Industry A small amount of the construction materials used for CP1 would be purchased within the extended study area. These purchases are predicted to increase sales and profits of businesses within the lower Sacramento River and Delta area during the construction period. This impact would be beneficial.

A significant amount of construction materials would be needed to raise Shasta Dam by 6.5 feet, as prescribed in CP1. Of these materials, a small amount would be purchased from construction-related businesses in the extended study area, including the lower Sacramento River and Delta area. These purchases may include raw or refined materials, infrastructure-related products, and/or equipment required for the construction process. As a result of the purchases expected, businesses in the lower Sacramento River and Delta portion of the extended study area are expected to experience a temporary increase in sales and profits during the construction period. Similar to businesses within the primary study area, increased sales and profits could be reinvested into the existing businesses, invested in new ventures or diversification, translated into increased salaries and wages for employees, or used in other ways. The exact scale of the increase in business sales and profits within the lower Sacramento River and Delta area would be speculative, but this amount likely would be substantial. Therefore, this impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-11 (CP1): Short-Term Increase in State Sales and Income Tax Revenues in the Lower Sacramento River and Delta Area from Construction-Related Personal Income and Purchases In addition to local tax revenues, CP1 is expected to increase short-term, construction-related State sales and income tax revenues received from businesses and residents of the lower Sacramento River and Delta portion of the extended study area. These additional revenues are expected to be cycled back to local government coffers through statewide programs and policies. This impact would be minor but beneficial.

As a result of the increased employment and personal income anticipated as a part of implementation of CP1, a short-term increase in State sales and income tax revenues also is expected to occur. In the construction period, more than $603.8million in personal income would be generated by direct, indirect, and induced employment, generated by the project. This large amount of income would direct substantial income tax revenues to the State via State income tax requirements. These additional revenues would contribute substantially to the State budget and would be distributed to jurisdictions within the lower Sacramento River and Delta portion of the extended study area via statewide programs and policies. This impact would be minor but beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-12 (CP1): Long-Term Reduction in the Adverse Economic Effects of Flooding in the Lower Sacramento River and Delta Area As a result of the added reservoir capacity under CP1, the overall risk of flooding and its related consequences below Shasta Dam is expected to be reduced. Although heavy rain events would continue to occur in the region, CP1 is intended to provide greater flexibility in flood control in the lower Sacramento River and Delta area because of the increased capacity of the reservoir. As a result, less damage to existing structures and a smaller loss of potential future development would be expected; this, in turn, would reduce salary and wage losses for residents in and near the lower Sacramento River floodplain and the Delta resulting from these catastrophic events, as well as business and personal income losses from such damage. Therefore, this impact would be beneficial.

Residents of the lower Sacramento River and Delta portion of the extended study area would benefit from the additional flexibility and flood control operations during flood events that would occur as a result of CP1. With the additional capacity provided by this alternative, the effects of large rain events would be reduced as a result of the improved management of systemwide flood control operations. Hydroelectric facilities within the lower Sacramento River and Delta area would be likely to experience flood events of somewhat less duration and magnitude, thus reducing the potential effects on vulnerable houses and property within the floodplain.

The loss of jobs and adverse effects on economic well-being and livelihoods often is an overlooked consequence of catastrophic flood events. Avoiding a larger number of these events and possibly decreasing the magnitude and duration of floods under certain high-flow events are expected to reduce the overall economic hardships faced by residents of the lower Sacramento River and Delta areas. The effects of heavy rain events would be better managed and the risk of flood-related effects could be reduced as far downstream as Sacramento.

In addition, fewer flooding events would result in less damage to businesses located adjacent to waterways during some flood events. This reduction in damage would reduce the amount of time employees would be without pay because of flood conditions and damage. This reduction in flood damage would reduce residents' salary and wage losses from these catastrophic events.

Implementation of CP1 would reduce damage to structures, loss of business and personal income, loss of jobs, and other adverse effects on economic well-being in the lower Sacramento River and Delta areas. Therefore, this impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

CVP/SWP Service Areas

Impact Socio-13 (CP1): Short-Term Increases in Sales and Profits for Businesses in the CVP and SWP Service Areas that Support the Construction Industry A small amount of the construction materials used during construction under CP1 would be purchased within the extended study area, including the CVP and SWP service areas. These purchases would result in a minor increase in sales and profits for a few businesses within the CVP and SWP service areas during the construction period of CP1. This impact would be minor but beneficial.

A small amount of the construction materials used during construction under CP1 is expected to be purchased from some construction-related businesses in the extended study area, including the CVP and SWP service areas. These purchases may include raw or refined materials, infrastructure-related products, and/or equipment required for the construction process. As a result of the purchases expected, a few businesses in the CVP and SWP service areas are expected to experience a short-term increase in sales and profits over the construction period. The exact scale of the increase in business sales and profits within the CVP and SWP service areas would be speculative, but would be minor given the large geographic area of the service areas. Therefore, this impact would be minor but beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-14 (CP1): Potential Temporary Reduction in Shasta Project Water or Hydropower Supplied to the CVP and SWP Service Areas during Construction Implementation of CP1 may require temporarily reducing the reservoir level at critical times during the construction period. This reduction in the reservoir level could temporarily reduce the amount of water or hydropower available from the dam and related hydropower infrastructure. Should this occur, sources of replacement water or hydropower would need to be secured. If these replacement resources were substantially more expensive, a minor negative effect on water or power customers may result. This impact would be potentially significant.

Construction activities implemented as part of CP1 would require adding large quantities of concrete to Shasta Dam. To complete this effort, it may be necessary to reduce the reservoir's water table to accommodate construction. A reduced water table may be needed at critical points in the construction process. Regardless of the approach needed, a reduced water table would limit the amount of water and/or hydropower that would be available from the dam for use in the CVP and SWP service areas. As a result, periods could occur in which water or hydropower availability within the CVP and SWP service areas may be more limited, especially during dry periods.

To address potential temporary shortages in water or hydropower caused by reduced availability at Shasta Dam, replacement water or hydropower supplies would need to be sourced elsewhere to maintain existing service needs. Depending on the conditions of the water or energy markets at the time of need, these replacement resources could be more expensive than water or hydropower obtained from Shasta Dam. The additional expense of obtaining water or hydropower resources could produce a minor negative effect on water and power customers if replacing these resources would be substantially more expensive. This impact would be potentially significant. Mitigation for this impact is proposed in Section 16.3.5, "Mitigation Measures."

Impact Socio-15 (CP1): Short-Term Increase in State Sales and Income Tax Revenues in the CVP and SWP Service Areas from Construction-Related Personal Income and Purchases CP1 is expected to increase short-term, construction-related, State sales and income tax revenues received from businesses and residents of the CVP and SWP service areas. These additional revenues are expected to be cycled back to local government coffers through statewide programs and policies. This impact would be beneficial.

As a result of the increased employment and personal income anticipated as a part of implementation of CP1, a short-term increase in State sales and income tax revenues would be likely to occur. During the construction period for CP1, more than $603.8 million in personal income would be generated by direct, indirect, and induced employment produced by the project. This large amount of income would direct substantial income tax revenues to the State, to meet State income tax requirements. These additional revenues would contribute substantially to the State budget and would be distributed to jurisdictions within the CVP and SWP service areas via statewide programs and policies. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-16 (CP1): Long-Term Increase in Agricultural Income and Jobs in the CVP and SWP Service Areas as a Result of Improved Water Availability and Reliability Based on SWAP modeling, improved water availability and reliability expected to result from implementation of CP1 would substantially increase agricultural net income in the CVP and SWP service areas and would increase the number of agricultural positions in these areas. This increase in production and jobs would contribute substantially to the continuation of this already strong industry in California. This impact would be beneficial.

Among CVP and SWP's water consumers, agricultural users benefit the most from increased water availability and reliability because of more consistent irrigation opportunities throughout the year. Based on the outputs of SWAP modeling, CP1 would improve long-term water availability and reliability within the CVP and SWP service areas by adding to water storage capacity. Long-term improvements to the availability and reliability of water are expected to allow farmers within the CVP and SWP service areas to substantially increase agricultural production, especially in dry years. It was estimated that CP1 would increase the net agricultural income within the 27 SWAP regions by more than $1.27 million in a normal year and up to $1.50 million during dry years. In wet years, net income is projected to increase to $1.89 million.

To support the increased agricultural production expected during the implementation of CP1, more agricultural workers would be needed. SWAP does not estimate the number of additional agricultural positions that would be created as a result of improved irrigation, but the resulting increase in water reliability and availability would have the potential to strengthen and extend the existing growing season in the CVP and SWP service areas. This would enable existing employees to work for longer periods in the fields and also would increase the number of workers needed during the growing season. These additional agricultural workers are expected to be distributed across the CVP and SWP service areas. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-17 (CP1): Reduction in Risk of Potential Water and Power Shortages (and Related Economic Activity) in the CVP and SWP Service Areas as a Result of Long-Term Improvements to Water and Power Supply Reliability
Implementation of CP1 would substantially increase Shasta Dam's storage capacity. As stated in Impact Socio-16 (CP1), this additional storage capacity would improve the long-term availability and reliability of water in the CVP and SWP service areas. Beyond increasing agricultural production, this improved availability and reliability would reduce the long-term risk of urban water and power shortages, and their related adverse economic consequences. This impact would be beneficial.

In addition to improving agricultural production, implementation of CP1 would increase water availability and reliability for industrial and urban users within the CVP and SWP service areas. For these users, the additional 265,000 acre-feet of storage capacity proposed by CP1 is expected to substantially reduce the long-term risk of water and power shortages from periodic flow constraints. As a result, water and power users would be likely to experience fewer water and power shortages caused by reduced reservoir levels, such as those experienced in dry years. This reduction in water and power shortages, along with avoidance of the related loss of economic production, would represent a substantial benefit for users in the CVP and SWP service areas. This benefit would be most pronounced for water- and power-intensive industries that are heavily dependent on consistent water and power availability. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

As with CP1, CP2 focuses on increasing water supply reliability and increasing anadromous fish survival. CP2 primarily consists of raising Shasta Dam by 12.5 feet, which, in combination with spillway modifications, would increase the height of the reservoir's full pool by 14.5 feet and enlarge the total storage capacity in the reservoir by 443,000 acre-feet to 5.0 MAF. CP2 would increase the maximum surface area of the pool of the reservoir to 31,600 acres. Shasta Dam operational guidelines would continue essentially unchanged, except during dry years and critical years, when 120,000 acre-feet and 60,000 acre-feet, respectively, of the increased storage capacity in Shasta Reservoir would be reserved to specifically focus on increasing M&I deliveries.

Implementing CP2 would result in the replacement or modification of 8 bridges and relocation of approximately 100 existing structures. The total construction cost associated with CP2 would be approximately $1,089 million.

CP2 would help reduce estimated future agricultural and M&I water shortages and would increase water supply reliability in the CVP/SWP service areas, by increasing water supplies for agricultural and M&I deliveries by at least 77,800 acre-feet per year in dry and critical years and increasing average annual deliveries by about 51,300 acre-feet per year. The majority of the increased dry and critical year water supplies (i.e., 67,100 acre-feet) would be for south-of-Delta agricultural and M&I deliveries. In addition, CP2 would provide hydropower benefits by increasing hydropower generation by approximately 90 GWh per year. In addition, the increased depth and volume of the cold-water pool in Shasta Reservoir would contribute to improving seasonal water temperatures for anadromous fish in the upper Sacramento River.

Shasta Lake and Vicinity and Upper Sacramento River (Shasta Dam to Red Bluff)

Impact Socio-1 (CP2): Short-Term Increase in Population and Housing Demand in the Primary Study Area Resulting from Construction-Related Activities According to Reclamation estimates, approximately 300 new direct jobs would be created as a result of construction activities associated with CP2. All 300 construction workers are expected to come from the local labor force; therefore, a short-term population increase is not expected. This impact would be less than significant.

This impact would be similar to Impact Socio-1 (CP1). Approximately 5 years of work (compared to the 4.5 years proposed under CP1) would be required to complete the construction activities proposed under CP2. As described above under Impact Socio-1 (CP1), a short-term population increase is not expected with implementation of CP2. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-2 (CP2): Short-Term Increases in Direct, Indirect, and Induced Employment in the Primary Study Area Related to Construction Activities Construction activities associated with CP2 are expected to generate approximately 300 new direct construction jobs, 600 indirect jobs in various construction-related support industries, and 600 induced jobs because of increased household spending in the primary study area. Individuals to fill these jobs would be drawn from the local community. These new jobs would provide important but temporary employment opportunities to many unemployed construction workers in the primary study area. This impact would be beneficial.

This impact would be the same as Impact Socio-2 (CP1) and would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-3 (CP2): Potential for Temporary Reduction in the Labor Force of Related Industrial Sectors in the Primary Study Area as a Result of Direct Construction-Related Employment With the creation of 300 new construction jobs resulting from CP2, the potential would exist for workers from other industries to move to jobs related to construction at Shasta Dam. Because of the size of the construction industry in the primary study area and the high unemployment rate in the area, this impact would be less than significant.

This impact would be the same as Impact Socio-3 (CP1) and would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-4 (CP2): Short-Term Increases in Direct, Indirect, and Induced Personal Income Paid to Employees in the Primary Study Area Hired for Construction-Related Activities Based on calculations completed as a part of the IMPLAN socioeconomic model process, more than $85.1 million in personal income would be directly paid to employees in the primary study area each year of the 5-year construction period under CP2. The combined $132.8 million in personal income that would be generated would represent an approximately 92percent increase in all annual personal income in the local economic study area. In addition, approximately $47.8 million in indirect and induced income is expected to be generated in various construction-related and other industries in the primary study area each year of construction under CP2. This impact would be beneficial.

This impact would be the same as Impact Socio-4 (CP1) and would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-5 (CP2): Short-Term Increases in Sales and Profits for Businesses in the Primary Study Area that Support the Construction Industry Most of the construction materials used for CP2 are expected to be purchased within the primary study area. These purchases would provide the local economy with increased sales and profits over the 5-year construction period. This impact would be beneficial.

This impact would be similar to but more beneficial than Impact Socio-5 (CP1). Because of the longer project duration and larger dam raise proposed under CP2, short-term increases in sales and profits for businesses that support the construction industry in the primary study area would be larger than those under CP1. During the construction period, implementation of CP2 is expected to generate more than $346.3 million per year in sales and profits for construction-related and service-oriented businesses that support the construction industry, with approximately $217.8 million in direct income and $128.5 indirect and induced income. The direct income would be $2.2 million less than under CP1; and, the induced income would be $600,000 less than under CP1. The additional time and materials required to implement CP2 over 5 years would generate more in sales and profits than CP1 for construction-related and service-oriented businesses. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-6 (CP2): Short-Term Increase in State and Local Sales Tax Revenues in the Primary Study Area from Construction-Related Personal Income and Purchases As stated above, implementation of CP2 is expected to result in a substantial increase in total personal income (direct, indirect, and induced) over the 5-year construction period. This additional income, in combination with construction-related purchases in the primary study area, would result in a substantial increase in local sales tax revenues from increased consumer spending in nearby cities and counties. Construction-related activities under CP2 also would be likely to result in a temporary increase in State sales and income tax revenues received from businesses and residents of the primary study area. The exact amount of State and local sales tax revenue increases would be speculative; however, this impact would be beneficial.

This impact would be similar to but would be more beneficial than Impact Socio-6 (CP1). Because of the larger total personal income (direct, indirect, and induced) and larger sales and profits for businesses over the construction period expected to result from implementation of CP2, the short-term increase in local sales tax revenues generated by CP2 would be greater than that from CP1 (see Impacts Socio-4 (CP2) and Socio-5 (CP2), above). Construction-related activities under CP2 also are expected to result in a temporary increase in State sales and income tax revenues received from businesses and residents of the primary study area. These additional revenues would likely be cycled back to local government coffers through statewide programs and policies. The increases in State sales and income taxes are expected to be larger under CP2 than under CP1. All of these increases would be beneficial for the relevant local jurisdictions. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-7 (CP2): Long-Term Reduction in the Adverse Economic Effects of Flooding in the Primary Study Area As a result of the added reservoir capacity created by CP2, the overall risk of flooding below Shasta Dam and its related consequences to the primary study area would be reduced. Although heavy rain events would continue to occur in the region and locally, the project is intended to provide greater flexibility in flood control downstream because of the increased capacity of the reservoir. As a result, less damage to existing structures and a smaller loss of potential future development would occur; this, in turn, would reduce salary and wage losses for residents of the primary study area, as well as business and personal income losses from such damage. Therefore, this impact would be beneficial.

This impact would be similar to but would be more beneficial than Impact Socio-7 (CP1). CP2 would increase the total storage capacity of Shasta Lake by 443,000 acre-feet. Therefore, CP2 would provide approximately 187,000 acre-feet more storage capacity in the reservoir than CP1. This additional capacity provided with the 12.5-foot dam raise would increase the flood control capabilities compared to both existing conditions and CP1, by further reducing the risk of flooding downstream from Shasta Dam. Therefore, the overall risk of flooding and its associated adverse effects on property, housing, and businesses downstream from Shasta Dam and residents throughout the primary study area would be further reduced.

The increased storage capacity proposed as a part of CP2 also would reduce the risk of job loss from flooding and its related effects to a greater extent than the capacity increase proposed under CP1. The increased storage capacity would further reduce the risk of flood-level conditions downstream from the dam. Related effects from flooding on the economic livelihood of residents of the primary study area would be similarly reduced.

Fewer flooding events would occur and less damage would be inflicted on property adjacent to downstream waterways during some flood events. This reduction in flood damage also would reduce residents’ salary and wage losses resulting from these catastrophic events.

For the reasons described above, this impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-8 (CP2): Long-Term Increases in Direct Employment in the Primary Study Area Related to Project Operations In the long term, implementation of CP2 is expected to create at least two new maintenance-related positions at the Shasta Dam facilities. These two positions would be permanent and would continue after the 5-year construction period is completed. This impact would be minor but beneficial.

This impact would be the same as Impact Socio-8 (CP1) and would be minor but beneficial. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta

Impact Socio-9 (CP2): Potential Temporary Increase in Indirect Employment in Construction-Related Businesses of the Lower Sacramento River and Delta Construction activities associated with CP2 would have the potential to result in a short-term increase in indirect employment within the lower Sacramento River and Delta portion of the extended study area. Depending on the location of construction material sourced outside of the primary study area, indirect increases in employment within construction-related businesses may result in the lower Sacramento River and Delta area. This impact would be beneficial.

This impact would be similar to but would be more beneficial than Impact Socio-9 (CP1). A larger potential temporary increase in indirect employment in construction-related businesses of the lower Sacramento River and Delta area would be expected under CP2 than under CP1. Estimated total construction costs for CP2 are approximately 9.5 percent higher than costs for CP1. Therefore, more income would be allocated to indirect positions in construction-related businesses under CP2. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-10 (CP2): Short-Term Increases in Sales and Profits for Businesses in the Lower Sacramento River and Delta Area that Support the Construction Industry A small amount of the construction materials used for CP2 would be purchased within the extended study area. These purchases are predicted to increase sales and profits of businesses within the lower Sacramento River and Delta area over the 5-year construction period of CP1. This impact would be beneficial.

This impact would be similar to but would be more beneficial than Impact Socio-10 (CP1). Because of the longer project duration and larger dam raise proposed under CP2, short-term increases in sales and profits for construction-related businesses in the lower Sacramento River and Delta area would be larger than those under CP1. The exact scale of the increase in business sales and profits within the lower Sacramento River and Delta area would be speculative, but because additional time and materials would be required, implementing CP2 would likely generate more sales and profits for construction-related and service-oriented businesses. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-11 (CP2): Short-Term Increase in State Sales and Income Tax Revenues in the Lower Sacramento River and Delta Area from Construction-Related Personal Income and Purchases In addition to local tax revenues, CP2 would increase short-term construction-related State sales and income tax revenues received from businesses and residents of the lower Sacramento River and Delta portion of the extended study area. These additional revenues would be cycled back to local government coffers through statewide programs and policies. This impact would be minor but beneficial.

This impact would be similar to but would be more beneficial than Impact Socio-11 (CP1) because the construction period would be longer and more construction materials would be needed. The increased employment and personal incomes anticipated as a part of implementation of CP2 would cause an increase in short-term construction-related State sales and income tax revenues received from businesses and residents of the lower Sacramento River and Delta portion of the extended study area. These additional revenues would be likely to be cycled back to local government coffers through statewide programs and policies. This impact would be minor but beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-12 (CP2): Long-Term Reduction in the Adverse Economic Effects of Flooding in the Lower Sacramento River and Delta Area As a result of the added reservoir capacity under CP2, the overall risk of flooding and its related consequences below Shasta Dam would be reduced. Although heavy rain events would continue to occur in the region, CP2 would provide greater flexibility in flood control in the lower Sacramento River and Delta area because of the increased capacity of the reservoir. As a result, less damage to existing structures and a smaller loss of potential future development would occur; this, in turn, would reduce salary and wage losses for residents in or near the lower Sacramento River floodplain and the Delta resulting from these catastrophic events, as well as would reduce business and personal income losses from such damage. Therefore, this impact would be beneficial.

This impact would be similar to but would be more beneficial than Impact Socio-12 (CP1). CP2 would provide approximately 187,000 acre-feet more storage capacity in the reservoir than CP1. This additional capacity would increase the flood control capabilities beyond the existing capabilities at Shasta Dam and the capabilities proposed under CP1, and would further reduce the risk of flooding downstream from the dam. The overall risk of flooding and its associated adverse effects on property, housing, businesses, and residents of the lower Sacramento River and Delta area would be reduced with implementation of CP2. Flood risk reduction effects identified earlier for CP1 would apply to CP2, but the positive effects would be greater because of the direct relationship between the proposed dam heights, corresponding capacity of the reservoir, and associated increase in flood control operations and management flexibility.

Increased storage capacity proposed as a part of CP2 also would reduce the risk of job loss from flooding and its related effects in the lower Sacramento River and Delta area, when compared to CP1. A reduction in the risk of flood-level conditions downstream from the dam would strengthen the economic livelihood of downstream residents in the lower Sacramento River and Delta area.

Fewer flooding events would occur and less damage would be inflicted on businesses located adjacent to downstream waterways during some flood events. This reduction in flood damage would reduce residents’ salary and wage losses resulting from these catastrophic events.

For the reasons described above, this impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

CVP/SWP Service Areas

Impact Socio-13 (CP2): Short-Term Increases in Sales and Profits for Businesses in the CVP and SWP Service Areas that Support the Construction Industry A small amount of the construction materials used during construction under CP2 would be purchased within the extended study area, including the CVP and SWP service areas. These purchases would result in a minor increase in sales and profits for a few businesses within the CVP and SWP service areas over the 5-year construction period of CP2. This impact would be minor but beneficial.

This impact would be similar to but would be more beneficial than Impact Socio-13 (CP1). Because of the longer project duration and larger dam raise proposed under CP2, short-term increases in sales and profits for some construction-related businesses in the extended study area, including the CVP and SWP service areas, would be larger than those for CP1. These increases have not been quantified, but the additional time and materials required to implement CP2 would be expected to generate more sales and profits for some construction-related and service-oriented businesses. This impact would be minor but beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-14 (CP2): Potential Temporary Reduction in Shasta Project Water or Hydropower Supplied to the CVP and SWP Service Areas during Construction Implementation of CP2 may require temporarily reducing the reservoir level at critical times during the construction period. This reduction in the reservoir level could temporarily reduce the amount of water or hydropower available from the dam and related hydropower infrastructure. Should this occur, sources of replacement water or hydropower would need to be secured. If these replacement resources were substantially more expensive, a minor negative effect on water or power customers may result. This impact would be potentially significant.

This impact would be similar to Impact Socio-14 (CP1), except that the project construction period would be longer and reductions in reservoir levels could last longer under CP2. This impact would be potentially significant. Mitigation for this impact is proposed in Section 16.3.5, "Mitigation Measures."

Impact Socio-15 (CP2): Short-Term Increase in State Sales and Income Tax Revenues in the CVP and SWP Service Areas from Construction-Related Personal Income and Purchases In addition to local tax revenue, CP2 would increase short-term construction-related State sales and income tax revenues received from businesses and residents of the CVP and SWP service areas. These additional revenues are expected to be cycled back to local government coffers through statewide programs and policies. This impact would be beneficial.

This impact would be similar to but would be more beneficial than Impact Socio-15 (CP1). Short-term increases in State sales and income taxes would be larger under CP2 than under CP1. All of these increases are expected to be more beneficial for the relevant local jurisdictions. This impact would be minor but beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-16 (CP2): Long-Term Increase in Agricultural Income and Jobs in the CVP and SWP Service Areas as a Result of Improved Water Availability and Reliability Based on SWAP modeling, improved water availability and reliability expected to result from implementation of CP2 would substantially increase agricultural net income in the CVP and SWP service areas and increase the number of agricultural positions in these areas. This increase in production and jobs would contribute substantially to the continuation of this already strong industry in California. This impact would be beneficial.

This impact would be similar to but would be more beneficial than Impact Socio-16 (CP1). Water supply reliability in the CVP/SWP service areas would be greater under CP2 than under CP1. Because of the increase in the availability and reliability of water associated with implementation of CP2, the long-term increase in indirect employment within the agricultural sector would be larger than under CP1. Based on the outputs of SWAP modeling, CP2 is expected to generate an additional $1.3 million in net income during normal years and up to $2.7 million during dry years, when compared to existing conditions. In wet years, net income under CP2 is projected to increase to $2.9 million. This overall increase in net income is expected to stimulate more employment opportunities in the agricultural sector to support the higher crop production that likely would be the result of additional irrigation deliveries under CP2 (compared to CP1). This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-17 (CP2): Reduction in Risk of Potential Water and Power Shortages (and Related Economic Activity) in the CVP and SWP Service Areas as a Result of Long-Term Improvements to Water and Power Supply Reliability Implementation of CP2 would substantially increase Shasta Dam's storage capacity. As stated in Impact Socio-16 (CP2), this additional storage capacity would improve the long-term availability and reliability of water in the CVP and SWP service areas. Beyond increasing agricultural production, this improved availability and reliability would reduce the long-term risk of urban water and power shortages, and their related adverse economic consequences. This impact would be beneficial.

This impact would be similar to but would be more beneficial than Impact Socio-17 (CP1). Mitigation for this impact is not needed, and thus not proposed.

CP3 – 18.5-Foot Dam Raise, Agricultural Water Supply Reliability and Anadromous Fish Survival

CP3 focuses on increasing agricultural water supply reliability while also increasing anadromous fish survival. This plan primarily consists of raising Shasta Dam by 18.5 feet, which, in combination with spillway modifications, would increase the height of the reservoir's full pool by 20.5 feet and enlarge the total storage capacity in the reservoir by 634,000 acre-feet to 5.19 MAF. CP3 would increase the maximum surface area of the pool to 32,300 acres. Because CP3 focuses on increasing agricultural water supply reliability, none of the increased storage capacity in Shasta Reservoir would be reserved for increasing M&I deliveries. Operations for water supply, hydropower, and environmental and other regulatory requirements would be similar to existing operations, with the additional storage retained for water supply reliability and to expand the cold-water pool for downstream anadromous fisheries.

Implementing CP3 would result in the replacement or modification of 8 bridges and relocation of approximately 130 existing structures. The total construction cost associated with CP3 would be approximately $1,257 million.

CP3 would help reduce estimated future agricultural water shortages and would increase water supply reliability in the CVP service area by increasing water supplies for agricultural deliveries, by at least 63,100 acre-feet per year in dry and critical years and increasing average annual deliveries by about 61,700 acre-feet per year. Almost half of the increased dry and critical year water supplies (i.e., 28,000 acre-feet) would be for south-of-Delta agricultural deliveries, with the remainder for north-of-Delta agricultural deliveries. In addition, CP3 would provide hydropower benefits by increasing hydropower generation, by approximately 90 GWh per year.

Shasta Lake and Vicinity and Upper Sacramento River (Shasta Dam to Red Bluff)

Impact Socio-1 (CP3): Short-Term Increase in Population and Housing Demand in the Primary Study Area Resulting from Construction-Related Activities According to Reclamation estimates, approximately 350 direct jobs would be created as a result of construction activities associated with CP3. All 350 construction workers are expected to come from the local labor force; therefore, a short-term population increase is not expected. This impact would be less than significant.

This impact would be similar to Impacts Socio-1 (CP1) and Socio-1 (CP2). CP3 would add 191,000 acre-feet of storage capacity beyond the capacity anticipated in CP2, for a total increase of 634,000 acre-feet. Approximately 350 construction workers would be needed to complete the 18.5-foot raise proposed for CP3, compared to 300 new construction workers required for CP1 and CP2. Approximately 5 years of work (compared to the 4.5 years proposed under CP1) would be required to complete the construction activities proposed under CP3. Workers for this effort also would come from the local labor pool. This impact

would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-2 (CP3): Short-Term Increases in Direct, Indirect, and Induced Employment in the Primary Study Area Related to Construction Activities Construction activities associated with CP3 are expected to generate approximately 350 direct construction jobs, 450 indirect jobs in various construction-related support industries, and 700 induced jobs because of increased household spending in the primary study area. Individuals to fill these jobs are expected to be drawn from the local community. These jobs are expected to provide important but temporary employment opportunities to many unemployed construction workers in the primary study area. This impact would be beneficial.

This impact would be similar to Impact Socio-2 (CP1) and Socio-2 (CP2). Under CP3, approximately 350 short-term, direct construction jobs would be created, in addition to 450 indirect jobs expected to be created in various construction-related support industries, and 700 induced jobs created because of increased household spending near the project area. Total direct, indirect, and induced employment under CP3 would be greater than CP1 and CP2, and these positions would last approximately 5 years under CP3, compared to 4.5 years under CP1. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-3 (CP3): Potential for Temporary Reduction in the Labor Force of Related Industrial Sectors in the Primary Study Area as a Result of Direct Construction-Related Employment With the creation of 350 construction jobs resulting from CP3, the potential would exist for workers from other industries to move to jobs related to construction at Shasta Dam. Because of the size of the construction industry in the primary study area and the high unemployment rate in the area, this impact would be less than significant.

This impact would be similar to Impacts Socio-3 (CP1) and Socio-3 (CP2). CP3 would require 50 more construction workers than required for CP1 and CP2. This impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-4 (CP3): Short-Term Increases in Direct, Indirect, and Induced Personal Income Paid to Employees in the Primary Study Area Hired for Construction-Related Activities Based on calculations completed as a part of the IMPLAN socioeconomic model process, more than $98.2 million in personal income would be directly paid to employees in the primary study area each year of the 5-year construction period under CP3. In addition, more than $55.2 million in indirect and induced income is expected to be generated in various construction-related and other industries in the primary study area each year of construction under CP3. The combined $153.3 million in personal income to be generated would represent an approximately 93 percent increase in all annual personal income in the local economic study area. This impact would be beneficial.

This impact would be similar to but would be more beneficial than Impacts Socio-4 (CP1) and Socio-4 (CP2). CP3 would generate $98.2 million in direct personal income each year of construction, from the 350 direct construction-related jobs that would be created. In addition, indirect and induced personal income totaling $55.2 million per year of construction would be generated in various construction-related and other industries in the primary study area that would support construction under CP3. The combined direct, indirect, and induced personal income resulting from CP3 would be approximately $153.3 million per year of construction within the local economic study area. This increase in personal income would represent an approximately 93 percent increase in all annual personal income in the local economic study area.

Direct, indirect, and induced annual personal income under CP3 would be greater than CP1 and CP2. Overall, a total income of $766.6 million would be generated under CP3 over the 5-year construction period, compared to a total of $603.8 million for CP1 and to a total of $664.1 million for CP2. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-5 (CP3): Short-Term Increases in Sales and Profits for Businesses in the Primary Study Area that Support the Construction Industry Most of the construction materials used for CP3 are expected to be purchased within the primary study area. These purchases would provide the local economy with increased sales and profits over the 5-year construction period. This impact would be beneficial.

This impact would be similar to but would be more beneficial than Impacts Socio-5 (CP1) and Socio-5 (CP2). CP3 would require the largest dam height increase and, therefore, the greatest construction expenditures over the total construction period. As a result, CP3 would generate more business sales and profits than CP1 and CP2 in construction-related and service-oriented businesses in the primary study area. During the construction period, implementation of CP3 is expected to generate more than $399.7 million per year in sales and profits for businesses that support the construction industry, with approximately $251.4 million in direct income and $148.3 in direct and induced income. CP3 would generate an overall total of $424.5 million and $267.1 million more in sales and profits than CP1 and CP2, respectively, for construction-related and service-oriented businesses. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-6 (CP3): Short-Term Increase in State and Local Sales Tax Revenues in the Primary Study Area from Construction-Related Personal Income and Purchases As stated above, implementation of CP3 is expected to result in a substantial increase in total personal income (direct, indirect, and induced) over the 5-year construction period. This additional income, in combination with the construction-related purchases in the primary study area, would result in a substantial increase in local sales tax revenues from increased consumer spending in nearby cities and counties. Construction-related activities under CP3 would be likely also to result in a temporary increase in State sales and income tax revenues received from businesses and residents of the primary study area. The exact amount of State and local sales tax revenue increases would be speculative: however, this impact would be beneficial.

This impact would be similar to but would be more beneficial than Impacts Socio-6 (CP1) and Socio-6 (CP2). CP3 would generate more direct, indirect, and induced personal income and more sales and profits for businesses over the construction period than CP1 and CP2 (see Impacts Socio-4 (CP3) and Socio-5 (CP3), above). This larger amount of personal income generated is expected to result in more local sales tax revenues in the primary study area than under the other two alternatives. Construction-related activities under CP3 also are expected to result in a temporary increase in State sales and income tax revenues received from businesses and residents of the primary study area. These additional revenues would be likely to be cycled back to local government coffers through statewide programs and policies. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-7 (CP3): Long-Term Reduction in the Adverse Economic Effects of Flooding in the Primary Study Area As a result of the added reservoir capacity created by CP3, the overall risk of flooding and its related consequences below Shasta Dam are expected to be reduced. Although heavy rain events would continue to occur in the region and locally, and potentially increase with global climate change, the project is intended to provide greater flexibility in flood control downstream because of the increased capacity of the reservoir. As a result, less damage to existing structures and a smaller loss of potential future development would occur; this, in turn, would reduce salary and wage losses for residents of the primary study area, as well as business and personal income losses from such damage. Therefore, this impact would be beneficial.

This impact would be similar to but would be more beneficial than Impacts Socio-7 (CP1) and Socio-7 (CP2). CP3 would create 634,000 acre-feet more storage capacity than current capacity, more than 40 percent more than would be provided by CP2. CP3 would, therefore, provide substantially more flood protection than either CP1 or CP2. As a result, CP3 would result in a greater reduction than CP1 and CP2 in the risk of damage to property and structures from flooding along the upper Sacramento River.

The increased storage capacity proposed as a part of CP3 would result in a larger decrease in the risk of job loss from flooding and its related effects than would occur under CP1 or CP2. CP3 would increase storage space in Shasta

Lake and would provide approximately 191,000 more acre-feet of storage than either of the two previous alternatives. The increased storage capacity would create a greater reduction in the risk of flood-level conditions downstream from the dam. Related effects from flooding on the economic livelihood of residents of the primary study area would similarly be reduced. In addition, the reduction in flood damage would reduce residents' salary and wage losses resulting from these catastrophic events.

For the reasons described above, this impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-8 (CP3): Long-Term Increases in Direct Employment in the Primary Study Area Related to Project Operations In the long term, implementation of CP3 would create at least two new maintenance-related positions at the Shasta Dam facilities. These two positions are expected to be permanent and would continue once the 5-year construction period is completed. This impact would be minor but beneficial.

This impact would be the same as Impacts Socio-8 (CP1) and Socio-8 (CP2) and would be minor but beneficial. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta

Impact Socio-9 (CP3): Potential Temporary Increase in Indirect Employment in Construction-Related Businesses of the Lower Sacramento River and Delta Construction activities associated with CP3 would have the potential to result in a short-term increase in indirect employment within the lower Sacramento River and Delta portion of the extended study area. Depending on the location of construction materials sourced outside of the primary study area, indirect increases in employment within some construction-related businesses may result in the lower Sacramento River and Delta area. This impact would be minor but beneficial.

This impact would be similar to but would be more beneficial than Impacts Socio-9 (CP1) and Socio-9 (CP2). A larger potential temporary increase in indirect employment in construction-related businesses of the lower Sacramento River and Delta area would be expected under CP3. Estimated total construction costs for CP3 are approximately 22.3 percent higher than costs for CP1 and 14.2 percent higher than costs for CP2. Therefore, more income would be allocated to indirect positions in construction-related businesses than would be expected under CP1 and CP2. This impact would be minor but beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-10 (CP3): Short-Term Increases in Sales and Profits for Businesses in the Lower Sacramento River and Delta Area that Support the Construction Industry A small amount of the construction materials used for CP3 would be purchased within the extended study area. These purchases are predicted to increase sales and profits of businesses within the lower Sacramento River and Delta area over the 5-year construction period of CP3. This impact would be beneficial.

This impact would be similar to but would be more beneficial than Impacts Socio-10 (CP1) and Socio-1 (CP2). Because of the longer project duration and greater construction expenditures associated with the larger dam raise proposed under CP3, short-term increases in sales and profits for construction-related businesses in the lower Sacramento River and Delta area would be larger than those for CP1 and CP2. These increases have not yet been quantified, but because additional time and materials would be required, implementing CP3 would generate more sales and profits for construction-related and service-oriented businesses. This impact would be minor but beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-11 (CP3): Short-Term Increase in State Sales and Income Tax Revenues in the Lower Sacramento River and Delta Area from Construction-Relate Personal Income and Purchases In addition to local tax revenues, CP3 is expected to increase short-term, construction-related, State sales and income tax revenues received from businesses and residents of the lower Sacramento River and Delta portion of the extended study area. These additional revenues are expected to be cycled back to local government coffers through statewide programs and policies. This impact would be minor but beneficial.

This impact would be similar to but would be more beneficial than Impacts Socio-11 (CP1) and Socio-11 (CP2) because the construction period would be longer and more construction materials would be needed. The increased employment and personal incomes anticipated as a part of implementation of CP3 would cause an increase in short-term, construction-related, State sales and income tax revenues received from some businesses and residents of the lower Sacramento River and Delta portion of the extended study area. These additional revenues likely would be cycled back to local government coffers through statewide programs and policies. This impact would be minor but beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-12 (CP3): Long-Term Reduction in the Adverse Economic Effects of Flooding in the Lower Sacramento River and Delta Area As a result of the added reservoir capacity under CP3, the overall risk of flooding and its related consequences below Shasta Dam would be reduced. Although heavy rain events would continue to occur in the region, as well as potentially increase with global climate change, CP3 is intended to provide greater flexibility in flood control in the lower Sacramento River and Delta area because of the increased capacity of the reservoir. As a result, less damage to existing structures and a smaller loss of potential future development would occur; this, in turn, would reduce salary and wage losses for residents in and near the lower Sacramento River floodplain and the Delta resulting from these catastrophic events, as well as would reduce business and personal income losses from such damage. Therefore, this impact would be beneficial.

This impact would be similar to but would be more beneficial than Impacts Socio-12 (CP1) and Socio-12 (CP2). CP3 would provide approximately 191,000 acre-feet more storage capacity in the reservoir than either of the two previous alternatives. This additional capacity would increase the flood control capabilities beyond the existing capabilities at Shasta Dam and the capabilities proposed under CP1 and CP2, and would further reduce the risk of flooding downstream from the dam. The overall risk of flooding and its associated adverse effects on property, housing, businesses, and residents of the lower Sacramento River and Delta area would be reduced with implementation of CP3. Flood risk reduction effects identified for CP1 and CP2 would apply to CP3, but the positive effects would be greater because of the direct relationship between the proposed dam heights, corresponding capacity of the reservoir, and associated increase in flood control operations and management flexibility.

Increased storage capacity proposed as a part of CP3 also would reduce the risk of job loss from flooding and its related effects in the lower Sacramento River and Delta area. A reduction in the risk of flood-level conditions downstream from the dam would strengthen the economic livelihood of downstream residents in the lower Sacramento River and Delta portion of the extended study area. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

CVP/SWP Service Areas

Impact Socio-13 (CP3): Short-Term Increases in Sales and Profits for Businesses in the CVP and SWP Service Areas that Support the Construction Industry A small amount of the construction materials used during construction under CP3 would be purchased within the extended study area. These purchases are predicted to increase sales and profits of some businesses within the CVP and SWP service areas over the 5-year construction period of CP3. This impact would be minor but beneficial.

This impact would be similar to but would be more beneficial than Impact Socio-13 (CP1) because the construction period would be longer and more construction materials would be needed. This impact would be minor but beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-14 (CP3): Potential Temporary Reduction in Shasta Project Water or Hydropower Supplied to the CVP and SWP Service Areas during Construction Implementation of CP3 may require temporarily reducing the reservoir level at critical times during the construction period. This reduction in the reservoir level could temporarily reduce the amount of water or hydropower available from the dam and related hydropower infrastructure. Should this occur, sources of replacement water or hydropower would need to be secured. If these replacement resources were substantially more expensive, a minor negative effect on water or power customers may result. This impact would be potentially significant.

This impact would be similar to Impact Socio-14 (CP1), except that the project construction period would be longer. This impact would be potentially significant. Mitigation for this impact is proposed in Section 16.3.5, "Mitigation Measures."

Impact Socio-15 (CP3): Short-Term Increase in State Sales and Income Tax Revenues in the CVP and SWP Service Areas from Construction-Related Personal Income and Purchases In addition to local tax revenue, CP3 is expected to increase short-term, construction-related, State sales and income tax revenues received from businesses and residents of the CVP and SWP service areas. These additional revenues are expected to be cycled back to local government coffers through statewide programs and policies. This impact would be beneficial.

This impact would be similar to but would be more beneficial than Impacts Socio-15 (CP1) and Socio-15 (CP2). Short-term increases in State sales and income taxes are expected to be larger under CP3 than under CP1 and CP2. All of these increases are expected to be more beneficial for the relevant local jurisdictions. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-16 (CP3): Long-Term Increase in Agricultural Income and Jobs in the CVP and SWP Service Areas as a Result of Improved Water Availability and Reliability Based on SWAP modeling, improved water availability and reliability expected to result from implementation of CP3 would substantially increase agricultural net income in the CVP and SWP service areas and increase the number of agricultural positions in these areas. This increase in production and jobs would contribute substantially to the continuation of this already strong industry in California. This impact would be beneficial.

This impact would be similar to but would be more beneficial than Impacts Socio-16 (CP1) and Socio-16 (CP2). CP3 would increase water supply reliability by increasing dry and critical year water supplies for CVP irrigation deliveries. Because of the increase in the availability and reliability of water associated with implementation of CP3, the long-term increase in indirect employment within the agricultural sector is expected to be larger than under CP1 and CP2. Based on the outputs of SWAP modeling, CP3 would generate an additional $5.1 million in net income during normal years and $8.5 million during dry years, when compared to existing conditions. In wet years, net income under CP3 is projected to decrease to $4.4 million. Overall, CP3 is projected to result in a greater increase in net income during average, dry, and wet years, when compared to net income projected for CP1 and CP2. The projected increase in net income under CP3 is expected to stimulate a greater number of employment opportunities in the agricultural sector than under CP1 and CP2, because higher crop production would be likely. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-17 (CP3): Reduction in Risk of Potential Water and Power Shortages (and Related Economic Activity) in the CVP and SWP Service Areas as a Result of Long-Term Improvements to Water and Power Supply Reliability Implementation of CP3 would substantially increase Shasta Dam's storage capacity. As stated in Impact Socio-16 (CP3), this additional storage capacity would improve long-term water availability and reliability in the CVP and SWP service areas. Beyond increasing agricultural production, this improved availability and reliability would reduce the long-term risk of urban water and power shortages, and their related adverse economic consequences. This impact would be beneficial.

This impact would be the similar to CP1 and CP2 and would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

CP4 and CP4A – 18.5-Foot Dam Raise, Anadromous Fish Focus with Water Supply Reliability

CP4 and CP4A focus on increasing anadromous fish survival while also increasing water supply reliability. By raising Shasta Dam 18.5 feet, in combination with spillway modifications, CP4 or CP4A would increase the height of the reservoir full pool by 20.5 feet. This increase in full pool height would add approximately 634,000 acre-feet of storage to the reservoir's capacity. Accordingly, storage in the overall full pool would be increased from 4.55 MAF to 5.19 MAF. CP4 or CP4A would involve augmenting spawning gravel and restoring riparian, floodplain, and side-channel habitat at up to six potential locations in the upper Sacramento River.

CP4A is identical to CP4 with the exception of Shasta Dam and Reservoir operations. CP4 and CP4A have similar reservoir operations in that they each dedicate a portion of the new storage in Shasta Lake for fisheries purposes; however, the portion of this dedicated storage varies. Approximately 378,000 acre-feet of the increased reservoir storage space of CP4 would be dedicated to increasing the supply of cold water for anadromous fish survival purposes. For CP4, operations for the remaining portion of increased storage (approximately 256,000 acre-feet) would be the same as in CP1, with 70,000 acre-feet reserved in dry years and 35,000 acre-feet reserved in critical years to specifically focus on increasing M&I deliveries.

Similarly, approximately 191,000 acre-feet of the increased reservoir storage space of CP4A would be dedicated to increasing the supply of cold water for anadromous fish survival purposes. For CP4A, operations for the remaining portion of increased storage (approximately 443,000 acre-feet) would be the same as in CP2, with 120,000 acre-feet reserved in dry years and 60,000 acre-feet reserved in critical years to specifically focus on increasing M&I deliveries. Implementing CP4 or CP4A would result in the replacement or modification of

8 bridges and relocation of approximately 130 existing structures. The total construction cost associated with CP4 or CP4A would be approximately $1,265 million and $1,266 million, respectively.

CP4 would help reduce estimated future agricultural and M&I water shortages and would increase water supply reliability in the CVP/SWP service areas by increasing water supplies for agricultural and M&I deliveries by at least 47,300 acre-feet per year in dry and critical years and increasing average annual deliveries by about 31,000 acre-feet per year. The majority of the increased dry and critical year water supplies (i.e., 42,700 acre-feet) would be for south-of-Delta agricultural and M&I deliveries. In addition, CP4 would provide hydropower benefits by increasing hydropower generation by approximately 133 GWh per year. Water supply reliability under CP4A would the same as under CP2. Implementing CP4A would help reduce estimated future agricultural water shortages in the CVP/SWP service areas by increasing water supplies for agricultural deliveries by at least 37,600 acre-feet per year in dry and critical years and increasing average annual deliveries by about 31,400 acre-feet per year. CP4A would provide hydropower benefits by increasing hydropower generation by approximately 130 GWh per year.

Shasta Lake and Vicinity and Upper Sacramento River (Shasta Dam to Red Bluff)

Impact Socio-1 (CP4 and CP4A): Short-Term Increase in Population and Housing Demand in the Primary Study Area Resulting from Construction-Related Activities According to Reclamation estimates, approximately 350 direct jobs would be created as a result of construction activities associated with CP4 or CP4A. All 350 construction workers are expected to come from the local labor force; therefore, a short-term population increase is not expected. This impact would be less than significant for CP4 or CP4A.

This impact would be the same as Impact Socio-1 (CP3) and would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

This impact would be the same as Impact Socio-1 (CP3) and would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-2 (CP4 and CP4A): Short-Term Increases in Direct, Indirect, and Induced Employment in the Primary Study Area Related to Construction Activities Construction activities associated with CP4 or CP4A are expected to generate approximately 350 construction jobs, 450 indirect jobs in various construction-related support industries, and 700 induced jobs because of increased household spending in the primary study area. Individuals to fill these jobs are expected to be drawn from the local community. These new jobs would provide important but temporary employment opportunities to many unemployed construction workers in the primary study area. This impact would be beneficial for CP4 or CP4A.

This impact would be the same as Impact Socio-2 (CP3) and would be beneficial for CP4. Mitigation for this impact is not needed, and thus not proposed.

This impact would be the same as Impact Socio-2 (CP3) and would be beneficial for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-3 (CP4 and CP4A): Potential for Temporary Reduction in the Labor Force of Related Industrial Sectors in the Primary Study Area as a Result of Direct Construction-Related Employment With the creation of 350 construction jobs resulting from CP4 or CP4A, the potential would exist for workers from other industries to move to jobs related to construction at Shasta Dam. Because of the size of the construction industry in the primary study area and the high unemployment rate in the area, this impact would be less than significant for CP4 or CP4A.

This impact would be the same as Impact Socio-3 (CP3) and would be less than significant for CP4. Mitigation for this impact is not needed, and thus not proposed.

This impact would be the same as Impact Socio-3 (CP3) and would be less than significant for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-4 (CP4 and CP4A): Short-Term Increases in Direct, Indirect, and Induced Personal Income Paid to Employees in the Primary Study Area Hired for Construction-Related Activities Construction activities for CP4 or CP4A would last 5-years, compared to 4.5 years for CP1. Additional construction activities would be required for augmenting spawning gravel and restoring riparian, floodplain, and side-channel habitat. Based on calculations completed as a part of the IMPLAN socioeconomic model process, more than $98.7 million and $98.8 million in personal income would be directly paid to employees in the primary study area each year of construction for CP4 and CP4A, respectively. In addition, more than $55.4 million in indirect and induced income would be generated in various construction-related and other industries in the primary study area each year of construction under CP4 or CP4A. The combined $154.2 million and 154.3 million for CP4 and CP4A, respectively, in personal income generated would represent an approximately 93 percent increase in all annual personal income in the local economic study area. This impact would be beneficial for CP4 or CP4A.

This impact for CP4 or CP4A would be similar to Impact Socio-4 (CP3). CP3 is estimated to generate $98.2 million in direct personal income each year of construction from the 350 direct construction-related jobs that would be created. In addition, indirect and induced personal income totaling $55.2 million per year of construction would be generated in various construction-related and other industries in the primary study area that would support construction under CP3. In combination, direct, indirect, and induced personal income resulting from CP3 would be approximately $153.3 million per year of construction within the local economic study area. This increase in personal income would represent an approximately 93 percent increase in all annual personal income in the local economic study area.

Additional construction activities associated with augmenting spawning gravel and restoring riparian, floodplain, and side-channel habitat would occur under CP4 or CP4A. During the 5-year construction period, more than $770.9 million and $771.4 million in personal income would be generated by direct, indirect, and induced employment produced with CP4 and CP4A, respectively, and this would be $4.3 million and $4.8 million more personal income than generated under CP3, respectively.

This impact would be beneficial for CP4. Mitigation for this impact is not needed, and thus not proposed.

This impact would be beneficial for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-5 (CP4 and CP4A): Short-Term Increases in Sales and Profits for Businesses in the Primary Study Area that Support the Construction Industry
Most of the construction materials used for CP4 or CP4A would be purchased within the primary study area. These purchases would provide the local economy with increased sales and profits over the 5-year construction period. This impact would be beneficial for CP4 or CP4A.

This impact for CP4 or CP4A would be similar to but more beneficial than Impact Socio-5 (CP3). During the construction period, implementation of CP4 or CP4A would generate more than $401.9 million and $402.2 million, respectively, per year in sales and profits for construction-related and service-oriented businesses that support the construction industry, with approximately $252.8 million and $253.0 million in direct income, respectively, and $149.1 million and $149.3 million in indirect and induced income, respectively. CP4 or CP4A would generate an overall total of $2.2 million and $2.5 million more per year, respectively, in sales and profits than CP3 for construction-related and service-oriented businesses.

This impact would be beneficial for CP4. Mitigation for this impact is not needed, and thus not proposed.

This impact would be beneficial for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-6 (CP4 and CP4A): Short-Term Increase in State and Local Sales Tax Revenues in the Primary Study Area from Construction-Related Personal Income and Purchases As stated above, implementation of CP4 or CP4A is expected to result in a substantial increase in total personal income (direct, indirect, and induced) over the 5-year construction period. This additional income, in combination with the construction-related purchases in the primary study area, would result in a substantial increase in local sales tax revenues from increased consumer spending in nearby cities and counties. Construction-related activities under CP4 or CP4A would likely result in a temporary increase in State sales and income tax revenues received from businesses and residents of the primary study area. The exact amount of State and local sales tax revenue increases would be speculative; however, this impact would be beneficial for CP4 or CP4A.

This impact for CP4 or CP4A would be similar but more beneficial than Impact Socio-6 (CP3). CP4 or CP4A would generate more direct, indirect, and induced personal income and more sales and profits for businesses over the construction period than CP3 (see Impacts Socio-4 (CP4 and CP4A) and Socio-5 (CP4 and CP4A), above).

This impact would be beneficial for CP4. Mitigation for this impact is not needed, and thus not proposed.

This impact would be beneficial for CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-7 (CP4 and CP4A): Long-Term Reduction in the Adverse Economic Effects of Flooding in the Primary Study Area As a result of the added reservoir capacity created by CP4 or CP4A, the overall risk of flooding and its related consequences below Shasta Dam would be reduced. Although heavy rain events would continue to occur in the region and locally, and potentially increase with global climate change, the project is intended to provide greater flexibility in flood control downstream because of the increased capacity of the reservoir. As a result, less damage to existing structures and a smaller loss of potential future development would occur; this, in turn, would reduce salary and wage losses for residents of the primary study area, as well as would reduce business and personal income losses from such damage. Therefore, this impact would be beneficial for CP4 or CP4A.

This impact for CP4 would be the same as Impact Socio-7 (CP3) and would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

This impact for CP4A would be the same as Impact Socio-7 (CP3) and would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-8 (CP4 and CP4A): Long-Term Increases in Direct Employment in the Primary Study Area Related to Project Operations In the long term, implementation of CP4 or CP4A would create at least two new maintenance-related positions at the Shasta Dam facilities. These two positions would be permanent and would continue once the 5-year construction period is completed. This impact would be minor but beneficial for CP4 or CP4A.

This impact for CP4 would be the same as Impact Socio-8 (CP3) and would be minor but beneficial. Mitigation for this impact is not needed, and thus not proposed.

This impact for CP4A would be the same as Impact Socio-8 (CP3) and would be minor but beneficial. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta

Impact Socio-9 (CP4 and CP4A): Potential Temporary Increase in Indirect Employment in Construction-Related Businesses of the Lower Sacramento River and Delta   Construction activities associated with CP4 or CP4A have the potential to result in a short-term increase in indirect employment within the lower Sacramento River and Delta portion of the extended study area. Depending on the location of construction material sourced outside of the primary study area, indirect increases in employment within construction-related businesses may result in the lower Sacramento River and Delta area. This impact would be minor but beneficial for CP4 or CP4A.

This impact for CP4 would be similar to Impact Socio-9 (CP3) and would be minor but beneficial. Mitigation for this impact is not needed, and thus not proposed.

This impact for CP4A would be similar to Impact Socio-9 (CP3) and would be minor but beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-10 (CP4 and CP4A): Short-Term Increases in Sales and Profits for Businesses in the Lower Sacramento River and Delta Area that Support the Construction Industry   A small amount of the construction materials used for CP4 or CP4A would be purchased within the extended study area. These purchases are predicted to increase sales and profits of some businesses within the lower Sacramento River and Delta area over the 5-year construction period of CP4 or CP4A. This impact would be minor but beneficial for CP4 or CP4A.

This impact for CP4 would be similar to Impact Socio-10 (CP3) and would be minor but beneficial. Mitigation for this impact is not needed, and thus not proposed.

This impact for CP4A would be similar to Impact Socio-10 (CP3) and would be minor but beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-11 (CP4 and CP4A): Short-Term Increase in State Sales and Income Tax Revenues in the Lower Sacramento River and Delta Area from Construction-Related Personal Income and Purchases In addition to local tax revenues, CP4 or CP4A is expected to increase short-term, construction-related, State sales and income tax revenues received from businesses and residents of the lower Sacramento River and Delta portion of the extended study area. These additional revenues are expected to be cycled back to local government coffers through statewide programs and policies. This impact would be minor but beneficial for CP4 or CP4A.

This impact for CP4 would be similar to Impact Socio-11 (CP3) and would be minor but beneficial. Mitigation for this impact is not needed, and thus not proposed.

This impact for CP4A would be similar to Impact Socio-11 (CP3) and would be minor but beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-12 (CP4 and CP4A): Long-Term Reduction in the Adverse Economic Effects of Flooding in the Lower Sacramento River and Delta Area As a result of the added reservoir capacity under CP4 or CP4A, the overall risk of flooding and its related consequences below Shasta Dam would be reduced. Although heavy rain events would continue to occur in the region, and potentially increase with global climate change, CP4 and CP4A are intended to provide greater flexibility in flood control in the lower Sacramento River and Delta area because of the increased capacity of the reservoir. As a result, less damage to existing structures and a smaller loss of potential future development would occur; this, in turn, would reduce salary and wage losses for residents in and near the lower Sacramento River floodplain and the Delta resulting from these catastrophic events, as well as would reduce business and personal income losses from such damage. Therefore, this impact would be beneficial for CP4 or CP4A.

This impact for CP4 would be the same as Impact Socio-12 (CP3) and would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

This impact for CP4A would be the same as Impact Socio-12 (CP3) and would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

CVP/SWP Service Areas

Impact Socio-13 (CP4 and CP4A): Short-Term Increases in Sales and Profits for Businesses in the CVP and SWP Service Areas that Support the Construction Industry A small amount of the construction materials used during construction under CP4 or CP4A would be purchased within the extended study area. These purchases are predicted to increase sales and profits of some businesses within the CVP and SWP service areas over the 5-year construction period of CP4 or CP4A. This impact would be minor but beneficial for CP4 or CP4A.

This impact for CP4 would be similar to Impact Socio-13 (CP3) and would be minor but beneficial. Mitigation for this impact is not needed, and thus not proposed.

This impact for CP4A would be similar to Impact Socio-13 (CP3) and would be minor but beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-14 (CP4 and CP4A): Potential Temporary Reduction in Shasta Project Water or Hydropower Supplied to the CVP and SWP Service Areas during Construction Implementation of CP4 or CP4A may require temporarily reducing the reservoir level at critical times during the construction period. This reduction in the reservoir level could temporarily reduce the amount of water or hydropower available from the dam and related hydropower infrastructure. Should this occur, sources of replacement water or hydropower would need to be secured. If these replacement resources were substantially more expensive, a minor negative effect on water or power customers may result. This impact would be potentially significant for CP4 or CP4A.

This impact for CP4 would be the same as Impact Socio-14 (CP3) and would be potentially significant. Mitigation for this impact is proposed in Section 16.3.5, "Mitigation Measures."

This impact for CP4A would be the same as Impact Socio-14 (CP3) and would be potentially significant. Mitigation for this impact is proposed in Section 16.3.5, "Mitigation Measures."

Impact Socio-15 (CP4 and CP4A): Short-Term Increase in State Sales and Income Tax Revenues in the CVP and SWP Service Areas from Construction-Related Personal Income and Purchases In addition to local tax revenue, CP4 or CP4A is expected to increase short-term, construction-related, State sales and income tax revenues received from some businesses and residents of the CVP and SWP service areas. These additional revenues are expected to be cycled back to local government coffers through statewide programs and policies. This impact would be minor but beneficial.

This impact for CP4 would be similar to Impact Socio-15 (CP3) and would be minor but beneficial. Mitigation for this impact is not needed, and thus not proposed.

This impact for CP4A would be similar to Impact Socio-15 (CP3) and would be minor but beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-16 (CP4 and CP4A): Long-Term Increase in Agricultural Income and Jobs within the CVP and SWP Service Areas as a Result of Improved Water Availability and Reliability Based on SWAP modeling, improved water availability and reliability expected to result from implementation of CP4 or CP4A would substantially increase agricultural net income in the CVP and SWP service areas. This increase in production would contribute substantially to the continuation of this already strong industry in California. This impact would be beneficial for CP4 or CP4A.

This impact for CP4 would be the same as Impact Socio-16 (CP1) and would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

This impact for CP4A would be similar to, but more beneficial than Impact Socio-16 (CP1) because water supply reliability in the CVP/SWP service areas would be greater under CP2 than under CP1. Because of the increase in the availability and reliability of water associated with implementation of CP4A, the long-term increase in indirect employment within the agricultural sector would be larger than under CP1. Therefore, the impact for CP4A would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-17 (CP4 or CP4A): Reduction in Risk of Potential Water and Power Shortages (and Related Economic Activity) in the CVP and SWP Service Areas as a Result of Long-Term Improvements to Water and Power Supply Reliability Implementation of CP4 or CP4A would substantially increase Shasta Dam's storage capacity. As stated in Impact Socio-16 (CP4 and CP4A), this additional storage capacity would improve long-term water availability and reliability in the CVP and SWP service areas. Beyond increasing agricultural production, this improved availability and reliability would reduce the long-term risk of urban water and power shortages, and their related adverse economic consequences. This impact would be beneficial for CP4 or CP4A.

This impact for CP4 would be the similar to Impact Socio-17 (CP1, CP2, and CP3) and would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

This impact for CP4A would be the similar to Impact Socio-17 (CP1, CP2, and CP3) and would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

CP5 – 18.5-Foot Dam Raise, Combination Plan

CP5 primarily focuses on increasing water supply reliability, anadromous fish survival, Shasta Lake area environmental resources, and recreation opportunities. By raising Shasta Dam 18.5 feet, in combination with spillway modifications, CP5 would increase the height of the reservoir full pool by 20.5 feet and enlarge the total storage capacity in the reservoir by 634,000 acre-feet to 5.19 MAF. CP5 would increase the maximum surface area of the pool to 32,300 acres. The existing temperature control device would be extended to achieve efficient use of the expanded cold-water pool. Shasta Dam operational guidelines would continue essentially unchanged, except during dry years and critical years, when 150,000 acre-feet and 75,000 acre-feet, respectively, of the increased storage capacity in Shasta Reservoir would be reserved to specifically focus on increasing M&I deliveries.

CP5 also would involve augmenting spawning gravel and restoring riparian, floodplain, and side-channel habitat at up to six potential locations in the upper Sacramento River. CP5 would involve constructing additional fish habitat in and along the shoreline of Shasta Lake and along the lower reaches of its tributaries, increasing recreation opportunities at Shasta Lake.

Implementing CP5 would result in the replacement or modification of 8 bridges and relocation of approximately 130 existing structures. The total construction cost associated with CP5 would be approximately $1,284 million.

CP5 would help reduce estimated future agricultural and M&I water shortages and would increase water supply reliability in the CVP/SWP service areas by increasing water supplies for agricultural and M&I deliveries by at least 113,500 acre-feet per year in dry and critical years and increasing average annual deliveries by about 75,900 acre-feet per year. The majority of the increased dry and critical year water supplies (i.e., 88,300 acre-feet) would be for south-of-Delta agricultural and M&I deliveries. In addition, CP5 would provide hydropower benefits by increasing hydropower generation by approximately 117 GWh per year.

Shasta Lake and Vicinity and Upper Sacramento River (Shasta Dam to Red Bluff)

Impact Socio-1 (CP5): Short-Term Increase in Population and Housing Demand in the Primary Study Area Resulting from Construction-Related Activities According to Reclamation estimates, approximately 360 direct jobs would be created as a result of construction activities associated with CP5. All 360 construction workers are expected to come from the local labor force; therefore, a short-term population increase is not expected. This impact would be less than significant.

This impact would be the similar to Impact Socio-1 (CP3) and would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-2 (CP5): Short-Term Increases in Direct, Indirect, and Induced Employment in the Primary Study Area Related to Construction Activities Construction activities associated with CP5 are expected to generate approximately 360 direct construction jobs, 470 indirect jobs in various construction-related support industries, and 710 induced jobs because of increased household spending in the primary study area. Individuals to fill these jobs are expected to be drawn from the local community. These new jobs would provide important but temporary employment opportunities to many unemployed construction workers in the primary study area. This impact would be beneficial.

This impact would be very similar to Impact Socio-2 (CP3), varying only with 10 more construction workers. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-3 (CP5): Potential for Temporary Reduction in the Labor Force of Related Industrial Sectors in the Primary Study Area as a Result of Direct Construction-Related Employment With the creation of 360 construction jobs resulting from CP5, the potential would exist for workers from other industries to move to jobs related to construction at Shasta Dam. Because of the size of the construction industry in the primary study area and the high unemployment rate in the area, this impact would be less than significant.

This impact would be similar to Impact Socio-3 (CP3). CP5 would only require 10 more construction workers than required for CP3, and the impact would be less than significant. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-4 (CP5): Short-Term Increases in Direct, Indirect, and Induced Personal Income Paid to Employees in the Primary Study Area Hired for Construction-Related Activities Construction activities for CP5 would last 5 years, compared to 4.5 years for CP1. Additional construction activities would be required for augmenting spawning gravel; restoring riparian, floodplain, and side-channel habitat; and creating fish habitat in and along the shoreline of Shasta Lake and along the lower reaches of its tributaries. Based on calculations completed as a part of the IMPLAN socioeconomic model process, more than $100.2 million in personal income would be directly paid to employees in the primary study area each year of construction. In addition, more than $56.3 million in indirect and induced income is expected to be generated in various construction-related and other industries in the primary study area each year of construction under CP5. The combined $156.5 million in personal income generated would represent an approximately 94 percent increase in all annual personal income in the local economic study area. This impact would be beneficial.

This impact would be similar to Impact Socio-4 (CP3). Under CP5, more than $100.2 million in personal income would be directly paid to employees in the primary study area each year of construction. In addition, more than $56.3 million in indirect and induced income is expected to be generated in various construction-related and other industries in the primary study area each year of construction. The combined $156.5 million in personal income generated would represent an approximately 94 percent increase in all annual personal income in the local economic study area.

Additional construction activities would be required for augmenting spawning gravel; restoring riparian, floodplain, and side-channel habitat; and creating fish habitat in and along the shoreline of Shasta Lake and along the lower reaches of its tributaries. During the 5-year construction period, more than $782.5 million in personal income is expected to be generated by direct, indirect, and induced employment produced by CP5, and this would be $15.9 million more personal income than generated under CP3. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-5 (CP5): Short-Term Increases in Sales and Profits for Businesses in the Primary Study Area that Support the Construction Industry Most of the construction materials used for CP5 are expected to be purchased within the primary study area. These purchases would provide the local economy with increased sales and profits over the 5-year construction period. This impact would be beneficial.

This impact would be similar to Impact Socio-5 (CP3). During the construction period, implementation of CP5 is expected to generate more than $408.0 million per year in sales and profits for construction-related and service-oriented businesses that support the construction industry, with approximately $256.6 million in direct income and $151.3 in direct and induced income. CP5 would generate an overall total of $8.3 million more per year in sales and profits than CP3 for construction-related and service-oriented businesses. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-6 (CP5): Short-Term Increase in State and Local Sales Tax Revenues in the Primary Study Area from Construction-Related Personal Income and Purchases As stated above, implementation of CP5 is expected to result in a substantial increase in total personal income (direct, indirect, and induced) over the 5-year construction period. This additional income, in combination with construction-related purchases in the primary study area, would result in a substantial increase in local sales tax revenues from increased consumer spending in nearby cities and counties. Construction-related activities under CP5 also would be likely to result in a temporary increase in State sales and income tax revenues received from businesses and residents of the primary study area. The exact amount of State and local sales tax revenue increases would be speculative; however, this impact would be beneficial.

This impact would be similar to but more beneficial than Impact Socio-6 (CP3). CP5 would generate more direct, indirect, and induced personal income and more sales and profits for businesses over the construction period than CP3 (see Impacts Socio-4 (CP5) and Socio-5 (CP5), above). This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-7 (CP5): Long-Term Reduction in the Adverse Economic Effects of Flooding in the Primary Study Area As a result of the added reservoir capacity created by CP5, the overall risk of flooding and its related consequences below Shasta Dam would be reduced. Although heavy rain events would continue to occur in the region and locally, and potentially increase with global climate change, the project is intended to provide greater flexibility in flood control downstream because of the increased capacity of the reservoir. As a result, less damage to existing structures and a smaller loss of potential future development would occur; this, in turn, would reduce salary and wage losses for residents of the primary study area, as well as would reduce business and personal income losses from such damage. Therefore, this impact would be beneficial.

This impact would be the same as Impact Socio-7 (CP3) and would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-8 (CP5): Long-Term Increases in Direct Employment in the Primary Study Area Related to Project Operations In the long term, implementation of CP5 would create at least two new maintenance-related positions at the Shasta Dam facilities. These two positions would be permanent and would continue once the 5-year construction period is completed. This impact would be minor but beneficial.

This impact would be the same as Impact Socio-8 (CP3) and would be minor but beneficial. Mitigation for this impact is not needed, and thus not proposed.

Lower Sacramento River and Delta

Impact Socio-9 (CP5): Potential Temporary Increase in Indirect Employment in Construction-Related Businesses of the Lower Sacramento River and Delta Construction activities associated with CP5 would have the potential to result in a short-term increase in indirect employment within the lower Sacramento River and Delta portion of the extended study area. Depending on the location of construction materials sourced outside of the primary study area, indirect increases in employment within construction-related businesses may result in the lower Sacramento River and Delta area. This impact would be minor but beneficial.

This impact would be similar to Impact Socio-9 (CP3) and would be minor but beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-10 (CP5): Short-Term Increases in Sales and Profits for Businesses in the Lower Sacramento River and Delta Area that Support the Construction Industry A small amount of the construction materials used for CP5 would be purchased within the extended study area. These purchases are predicted to increase sales and profits of some businesses within the lower Sacramento River and Delta area over the 5-year construction period of CP5. This impact would be minor but beneficial.

This impact would be similar to Impact Socio-10 (CP3) and would be minor but beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-11 (CP5): Short-Term Increase in State Sales and Income Tax Revenues in the Lower Sacramento River and Delta Area from Construction-Related Personal Income and Purchases In addition to local tax revenues, CP5 is expected to increase short-term construction-related State sales and income tax revenues received from businesses and residents of the lower Sacramento River and Delta portion of the extended study area. These additional revenues are expected to be cycled back to local government coffers through statewide programs and policies. This impact would be minor but beneficial.

This impact would be similar to Impact Socio-11 (CP3) and would be minor but beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-12 (CP5): Long-Term Reduction in the Adverse Economic Effects of Flooding in the Lower Sacramento River and Delta Area As a result of the added reservoir capacity under CP5, the overall risk of flooding and its related consequences below Shasta Dam would be reduced. Although heavy rain events would continue to occur in the region, and potentially increase with global climate change, CP5 is intended to provide greater flexibility in flood control in the lower Sacramento River and Delta area because of the increased capacity of the reservoir. As a result, less damage to existing structures and a smaller loss of potential future development would occur; this, in turn, would reduce salary and wage losses for residents in and near the lower Sacramento River floodplain and the Delta resulting from these catastrophic events, as well as would reduce business and personal income losses from such damage. Therefore, this impact would be beneficial.

This impact would be similar to Impact Socio-12 (CP3) and would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

CVP/SWP Service Areas

Impact Socio-13 (CP5): Short-Term Increases in Sales and Profits for Businesses in the CVP and SWP Service Areas that Support the Construction Industry A small amount of the construction materials used during construction under CP5 would be purchased within the extended study area, including the CVP and SWP service areas. These purchases are predicted to increase sales and profits of some businesses within the CVP and SWP service areas over the 5-year construction period of CP5. This impact would be minor but beneficial.

This impact would be similar to Impact Socio-13 (CP3) and would be minor but beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-14 (CP5): Potential Temporary Reduction in Shasta Project Water or Hydropower Supplied to the CVP and SWP Service Areas During

Construction Implementation of CP5 may require temporarily reducing the reservoir level at critical times during the construction period. This reduction in the reservoir level could temporarily reduce the amount of water or hydropower available from the dam and related hydropower infrastructure. Should this occur, sources of replacement water or hydropower would need to be secured. If these replacement resources were substantially more expensive, a minor negative effect on water or power customers may result. This impact would be potentially significant.

This impact would be similar to Impact Socio-14 (CP3) and would be potentially significant. Mitigation for this impact is proposed in Section 16.3.5, "Mitigation Measures."

Impact Socio-15 (CP5): Short-Term Increase in State Sales and Income Tax Revenues in the CVP and SWP Service Areas from Construction-Related Personal Income and Purchases In addition to local tax revenue, CP5 is expected to increase short-term construction-related State sales and income tax revenues received from some businesses and residents of the CVP and SWP service areas. These additional revenues are expected to be cycled back to local government coffers through statewide programs and policies. This impact would be minor but beneficial.

This impact would be similar to Impact Socio-15 (CP3) and would be minor but beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-16 (CP5): Long-Term Increase in Agricultural Income and Jobs in the CVP and SWP Service Areas as a Result of Improved Water Availability and Reliability Based on SWAP modeling, improved water availability and reliability expected to result from implementation of CP5 would substantially increase agricultural net income in the CVP and SWP service areas. This increase in production would contribute substantially to the continuation of this already strong industry in California. This impact would be beneficial.

This impact would be similar to Impact Socio-16 (CP3). The increase in the availability and reliability of water associated with implementation of CP5 would result in the long-term increase in indirect employment within the agricultural sector; however, this indirect increase is expected to be slightly less than under CP3. Based on the outputs of SWAP modeling, CP5 would generate an additional $2.6 million in net income during normal years and up to $5.7 million during dry years, when compared to existing conditions. In wet years, net income under CP5 is projected to increase to $3.4 million. This impact would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

Impact Socio-17 (CP5): Reduction in Risk of Potential Water and Power Shortages (and Related Economic Activity) in the CVP and SWP Service Areas as a Result of Long-Term Improvements to Water and Power Supply Reliability

Implementation of CP5 would substantially increase Shasta Dam's storage capacity. As stated in Impact Socio-16 (CP5), this additional storage capacity would improve long-term water availability and reliability in the CVP and SWP service areas. Beyond increasing agricultural production, this improved availability and reliability would reduce the long-term risk of urban water and power shortages, and their related adverse economic consequences. This impact would be beneficial.

This impact would be the similar to the other CPs and would be beneficial. Mitigation for this impact is not needed, and thus not proposed.

16.3.5 Mitigation Measures

Table 16-1 presents a summary of mitigation measures for socioeconomics, population, and housing.

Table 16-1. Summary of Mitigation Measures for Socioeconomics, Population, and Housing

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/ CP4A	CP5
Impact Socio-1 (No-Action): Potential for Reduced Employment Opportunities for Lower Sacramento River and Delta Area Residents	LOS before Mitigation	PS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.				
Impact Socio-1 (CP1–CP5): Short-Term Increase in Population and Housing Demand in the Primary Study Area Resulting from Construction-Related Activities	LOS after Mitigation	PS	LTS	LTS	LTS	LTS	LTS
Impact Socio-2 (No-Action): Potential for Temporary Disruptions in Business and Industrial Activity in the Lower Sacramento River and Delta Area	LOS before Mitigation	PS	B	B	B	B	B
	Mitigation Measure	None required.	None needed; thus, none proposed.				
Impact Socio-2 (CP1–CP5): Short-Term Increases in Direct, Indirect, and Induced Employment in the Primary Study Area Related to Construction Activities	LOS after Mitigation	PS	B	B	B	B	B
Impact Socio-3 (No-Action): Potential for Reduced Employment Opportunities for Residents Within the CVP and SWP Service Areas	LOS before Mitigation	PS	LTS	LTS	LTS	LTS	LTS
	Mitigation Measure	None required.	None needed; thus, none proposed.				
Impact Socio-3 (CP1–CP5): Potential for Temporary Reduction in the Labor Force of Related Industrial Sectors in the Primary Study Area as a Result of Direct Construction-Related Employment	LOS after Mitigation	PS	LTS	LTS	LTS	LTS	LTS
Impact Socio-4 (No-Action): Potential for Temporary Disruptions in Business and Industrial Activity in the CVP and SWP Service Areas	LOS before Mitigation	PS	B	B	B	B	B
	Mitigation Measure	None required.	None needed; thus, none proposed.				
Impact Socio-4 (CP1–CP5): Short-Term Increases in Direct, Indirect, and Induced Personal Income Paid to Employees in the Primary Study Area Hired for Construction-Related Activities	LOS after Mitigation	PS	B	B	B	B	B

Table 16-1. Summary of Mitigation Measures for Socioeconomics, Population, and Housing (contd.)

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/CVP 4A	CP5
Impact Socio-5: Short-Term Increases in Sales and Profits for Businesses in the Primary Study Area that Support the Construction Industry	LOS before Mitigation	NA	B	B	B	B	B
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	NA	B	B	B	B	B
Impact Socio-6: Short-Term Increase in State and Local Sales Tax Revenues in the Primary Study Area from Construction-Related Personal Income and Purchases	LOS before Mitigation	NA	B	B	B	B	B
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	NA	B	B	B	B	B
Impact Socio-7: Long-Term Reduction in the Adverse Economic Effects of Flooding in the Primary Study Area	LOS before Mitigation	NA	B	B	B	B	B
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	NA	B	B	B	B	B
Impact Socio-8: Long-Term Increases in Direct Employment in the Primary Study Area Related to Project Operations	LOS before Mitigation	NA	B	B	B	B	B
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	NA	B	B	B	B	B
Impact Socio-9: Potential Temporary Increase in Indirect Employment in Construction-Related Businesses of the Lower Sacramento River and Delta	LOS before Mitigation	NA	B	B	B	B	B
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	NA	B	B	B	B	B
Impact Socio-10: Short-Term Increases in Sales and Profits for Businesses in the Lower Sacramento River and Delta Area that Support the Construction Industry	LOS before Mitigation	NA	B	B	B	B	B
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	NA	B	B	B	B	B
Impact Socio-11: Short-Term Increase in State Sales and Income Tax Revenues in the Lower Sacramento River and Delta Area from Construction-Related Personal Income and Purchases	LOS before Mitigation	NA	B	B	B	B	B
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	NA	B	B	B	B	B
Impact Socio-12: Long-Term Reduction in the Adverse Economic Effects of Flooding in the Lower Sacramento River and Delta Area	LOS before Mitigation	NA	B	B	B	B	B
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	NA	B	B	B	B	B

Table 16-1. Summary of Mitigation Measures for Socioeconomics, Population, and Housing (contd.)

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/ CP4A	CP5
Impact Socio-13: Short-Term Increases in Sales and Profits for Businesses in the CVP and SWP Service Areas that Support the Construction Industry	LOS before Mitigation	NA	B	B	B	B	B
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	NA	B	B	B	B	B
Impact Socio-14: Potential Temporary Reduction in Shasta Project Water or Hydropower Supplied to the CVP and SWP Service Areas during Construction	LOS before Mitigation	NA	PS	PS	PS	PS	PS
	Mitigation Measure	None required.	Mitigation Measure Socio-14: Secure Replacement Water or Hydropower During Project Construction.				
	LOS after Mitigation	NA	LTS	LTS	LTS	LTS	LTS
Impact Socio-15: Short-Term Increase in State Sales and Income Tax Revenues in the CVP and SWP Service Areas from Construction-Related Personal Income and Purchases	LOS before Mitigation	NA	B	B	B	B	B
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	NA	B	B	B	B	B
Impact Socio-16: Long-Term Increase in Agricultural Income and Jobs in the CVP and SWP Service Areas as a Result of Improved Water Availability and Reliability	LOS before Mitigation	NA	B	B	B	B	B
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	NA	B	B	B	B	B
Impact Socio-17: Reduction in Risk of Potential Water and Power Shortages (and Related Economic Activity) in the CVP and SWP Service Areas as a Result of Long-Term Improvements to Water and Power Supply Reliability	LOS before Mitigation	NA	B	B	B	B	B
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	NA	B	B	B	B	B

Key:
B = beneficial
CP = Comprehensive Plan
CVP = Central Valley Project
LOS = level of significance
LTS = less than significant
NA = not applicable
PS = potentially significant
SWP = State Water Project

No-Action Alternative

No mitigation measures are needed for this alternative.

CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

No mitigation is needed for Impacts Socio-1 (CP1) through Socio-13 (CP1) and Impacts Socio-15 (CP1) through Socio-17 (CP1). Mitigation is provided below for the other impact of CP1.

Mitigation Measure Socio-14 (CP1): Secure Replacement Water or Hydropower During Project Construction To address potential temporary shortages in water or hydropower caused by reduced availability at Shasta Dam during construction, replacement water or hydropower supplies would need to be sourced elsewhere to maintain current service needs. Depending on the conditions of the water or energy markets at the time of need, these replacement resources could be more expensive than water or hydropower obtained from Shasta Dam. The additional expense of obtaining water or hydropower resources could potentially produce a minor negative effect on water and power customers, if replacement of these resources is substantially more expensive.

To eliminate the potential impact of project construction on water and/or hydropower purchases, Reclamation will identify the need for replacement water or hydropower early in project implementation and will secure such resources at the lowest cost possible. Replacement water or hydropower would be available from a number of sources within or external to the CVP. Reclamation will provide these replacement resources to business and industry in the CVP and SWP service areas at costs comparable to water or hydropower obtained from Shasta Dam. Reclamation will provide replacement water or hydropower at levels equal to the loss of water or hydropower caused by project construction.

Implementation of this mitigation measure would reduce Impact Socio-14 (CP1) to a less-than-significant level.

CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

No mitigation is needed for Impacts Socio-1 (CP2) through Socio-13 (CP2) and Impacts Socio-15 (CP2) through Socio-17 (CP2). Mitigation is provided below for the other impact of CP2.

Mitigation Measure Socio-14 (CP2): Secure Replacement Water or Hydropower during Project Construction This mitigation measure is identical to Mitigation Measure Socio-14 (CP1). Implementation of this mitigation measure would reduce Impact Socio-14 (CP2) to a less-than-significant level.

CP3 – 18.5-Foot Dam Raise, Agricultural Water Supply Reliability and Anadromous Fish Survival

No mitigation is needed for Impacts Socio-1 (CP3) through Socio-13 (CP3) and Impacts Socio-15 (CP3) through Socio-17 (CP3). Mitigation is provided below for the other impact of CP3.

Mitigation Measure Socio-14 (CP3): Secure Replacement Water or Hydropower During Project Construction This mitigation measure is identical to Mitigation Measure Socio-14 (CP1). Implementation of this mitigation measure would reduce Impact Socio-14 (CP3) to a less-than-significant level.

CP4 and CP4A – 18.5-Foot Dam Raise, Anadromous Fish Focus with Water Supply Reliability

No mitigation is needed for Impacts Socio-1 (CP4 and CP4A) through Socio-13 (CP4 and CP4A) and Impacts Socio-15 (CP4 and CP4A) through Socio-17 (CP4 and CP4A). Mitigation is provided below for the other impact of CP4 or CP4A.

Mitigation Measure Socio-14 (CP4 and CP4A): Secure Replacement Water or Hydropower During Project Construction This mitigation measure is identical to Mitigation Measure Socio-14 (CP1). Implementation of this mitigation measure would reduce Impact Socio-14 (CP4 and CP4A) to a less-than-significant level.

CP5 – 18.5-Foot Dam Raise, Combination Plan

No mitigation is needed for Impacts Socio-1 (CP5) through Socio-13 (CP5) and Impacts Socio-15 (CP5) through Socio-17 (CP5). Mitigation is provided below for the other impact of CP5.

Mitigation Measure Socio-14 (CP5): Secure Replacement Water or Hydropower During Project Construction This mitigation measure is identical to Mitigation Measure Socio-14 (CP1). Implementation of this mitigation measure would reduce Impact Socio-14 (CP5) to a less-than-significant level.

16.3.6 Cumulative Effects

Chapter 3, "Considerations for Describing the Affected Environment and Environmental Consequences," gives an overview of the cumulative effects analysis, including the relationship to the CALFED Bay-Delta Program Programmatic EIS/EIR cumulative impacts analysis, qualitative and quantitative assessment, past and future actions in the study area, and significance criteria. Table 3-1, "Present and Reasonably Foreseeable Future Actions Included in the Analysis of Cumulative Impacts, by Resource Area," in Chapter 3, lists the present and reasonably foreseeable future projects considered quantitatively and qualitatively within the cumulative impacts analysis. This cumulative impacts analysis accounts for potential project impacts combined with the impacts of existing facilities, conditions, land uses, and reasonably foreseeable actions expected to occur in the study area on a qualitative and quantitative level. Projects listed in Table 3-1 that could contribute to cumulative impacts on socioeconomics, population and housing in the primary and extended study area include, but are not limited to, projects listed under Quantitative Analysis and those projects under Qualitative Analysis that include Los Vaqueros Reservoir Expansion, Bay-Delta Conservation Plan, Upper San Joaquin River Basin Storage Investigation, and Mountain Gate at Shasta Mixed Use Area Plan.

Water reliability and electrical demand are expected to become increasingly important issues as demand for water and electricity increases to meet the needs of California's growing population. Over time, water conservation and reuse efforts will increase and water provision is expected to shift from such areas as agricultural production to urban uses. Environmental restoration, flood control, and hydropower generation are expected to continue in a manner similar to existing conditions.

CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

Primary Study Area In the primary study area, effects related to increases in population and housing during construction under CP1 would be less than significant. In combination with past, present, and reasonably foreseeable future projects, this incremental contribution to overall increases in population and housing demand would not be significant or cumulatively considerable. The combined effect of these projects and the SLWRI would not induce substantial growth in population, produce a substantial burden on the existing housing stock within the local community, or require sizeable numbers of workers from outside the local area. Implementing CP1 would result in beneficial effects on employment and the labor force, business and industrial activity, and government and finance. Thus, the project would not result in a cumulatively considerable incremental contribution to significant cumulative impacts on socioeconomic resources.

Extended Study Area Without mitigation, CP1 could cause a potentially significant adverse effect on business and industrial activity in the CVP and SWP service areas. This adverse effect would be a potential temporary reduction in Shasta project water or hydropower supplied to CVP and SWP service areas during construction. With implementation of Mitigation Measure Socio-14 (CP1), adverse effects from CP1 would be fully mitigated because Reclamation would secure replacement water or hydropower during project construction. Therefore, the project would not make a cumulatively considerable incremental contribution to a significant cumulative impact related to the temporary construction-related reduction in water or hydropower supplies to the CVP and SWP service areas.

Implementing CP1 also would result in beneficial effects on employment and the labor force, business and industrial activity, and government and finance.

Thus, the project would not result in a cumulatively considerable incremental contribution to significant cumulative impacts on socioeconomic resources.

CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

Primary Study Area In the primary study area, effects related to increases in population and housing during construction under CP2 would be less than significant. In combination with past, present, and reasonably foreseeable future projects, this incremental contribution to overall increases in population and housing demand would not be significant or cumulatively considerable. The combined effect of these projects and the SLWRI would not induce substantial growth in population, produce a substantial burden on the existing housing stock within the local community, or require sizeable numbers of workers from outside the local area. Implementing CP2 would cause beneficial effects on employment and the labor force, business and industrial activity, and government and finance. Overall, the beneficial effects of CP2 in the primary study area would be greater than those of CP1. Thus, the project would not result in a cumulatively considerable incremental contribution to significant cumulative impacts on socioeconomic resources.

Extended Study Area The adverse effects of CP2 would be the same as those of CP1. With implementation of Mitigation Measure Socio-14 (CP2), adverse effects from CP2 would be fully mitigated because Reclamation would secure replacement water or hydropower during project construction. Therefore, the project would not make a cumulatively considerable incremental contribution to significant cumulative impacts related to the temporary reduction in water or hydropower supplies to the CVP and SWP service areas.

Implementing CP2 would result in less-than-significant impacts on population and housing and also would have beneficial impacts on employment and the labor force, business and industrial activity, and government and finance. Overall, the beneficial effects of CP2 in the extended study area would be greater than those of CP1. Thus, the project would not result in a cumulatively considerable incremental contribution to significant cumulative impacts on socioeconomic resources.

CP3 – 18.5-Foot Dam Raise, Agricultural Water Supply Reliability and Anadromous Fish Survival

Primary Study Area In the primary study area, effects related to increases in population and housing during construction under CP3 would be less than significant. In combination with past, present, and reasonably foreseeable future projects, this incremental contribution to increases in population and housing demand would not be significant or cumulatively considerable. The combined effect of these projects and the SLWRI would not induce substantial growth in population, produce a substantial burden on the existing housing stock within the local community, or require sizeable numbers of workers from outside the local area. CP3 would have beneficial impacts on employment and the labor force, business and industrial activity, and government and finance. Overall, the beneficial effects of CP3 in the primary study area would be greater than those of CP1 and CP2. Thus, the project would not result in a cumulatively considerable incremental contribution to significant cumulative impacts on socioeconomic resources.

Extended Study Area The adverse effects of CP3 would be the same as those of CP1. With implementation of Mitigation Measure Socio-14 (CP3), adverse impacts from CP3 would be fully mitigated because Reclamation would secure replacement water or hydropower during project construction. Therefore, the project would not make a cumulatively considerable incremental contribution to significant cumulative impacts related to the temporary reduction during construction in water or hydropower supplies to the CVP and SWP service areas.

Implementing CP3 would result in less-than-significant impacts on population and housing and also would have beneficial effects on employment and the labor force, business and industrial activity, and government and finance. Overall, the beneficial effects of CP3 in the extended study area would be greater than those of CP1 and CP2. Thus, the project would not result in a cumulatively considerable incremental contribution to significant cumulative impacts on socioeconomic resources.

CP4 and CP4A – 18.5-Foot Dam Raise, Anadromous Fish Focus with Water Supply Reliability

Primary Study Area In the primary study area, effects related to increases in population and housing during the construction of CP4 or CP4A would be less than significant. In combination with past, present, and reasonably foreseeable future projects, this incremental contribution to increases in population and housing demand would not be significant or cumulatively considerable. The combined effect of these projects and the SLWRI would not induce substantial growth in population, produce a substantial burden on the existing housing stock within the local community, or require sizeable numbers of workers from outside the local area. CP4 or CP4A would have beneficial impacts on employment and the labor force, business and industrial activity, and government and finance. Overall, in the primary study area, the beneficial impacts of CP4 or CP4A would be the same as those of CP3. Thus, the project would not result in a cumulatively considerable incremental contribution to cumulative significant impacts on socioeconomic resources.

Extended Study Area The adverse impacts of CP4 would be the same as those of CP1. The adverse impacts of CP4A would be the same as those of CP2.With implementation of Mitigation Measure Socio-14 (CP4 and CP4A), adverse effects from CP4 or CP4A would be fully mitigated because Reclamation would secure replacement water or hydropower during project construction. Therefore, the project would not make a cumulatively considerable incremental contribution to significant cumulative impacts related to the temporary reduction in water or hydropower supplies to the CVP and SWP service areas.

The implementation of CP4 or CP4A would result in less-than-significant impacts on population and housing and also would have beneficial impacts on employment and the labor force, business and industrial activity, and government and finance. In the extended study area, the beneficial impacts of CP4 or CP4A for population and housing, employment, and the labor force would be the same as those of CP3. For business and industrial activity, CP4 or CP4A would be more beneficial than CP3. Thus, the project would not result in a cumulatively considerable incremental contribution to significant cumulative impacts on socioeconomic resources.

CP5 – 18.5-Foot Dam Raise, Combination Plan

Primary Study Area In the primary study area, effects related to increases in population and housing during construction under CP5 would be less than significant. In combination with past, present, and reasonably foreseeable future projects, this incremental contribution to increases in population and housing demand would not be significant or cumulatively considerable. The combined effects of these projects and the SLWRI would not induce substantial growth in population, produce a substantial burden on the existing housing stock within the local community, or require sizeable numbers of workers from outside the local area. CP5 would cause beneficial impacts on employment and the labor force, business and industrial activity, and government and finance. Overall, in the primary study area, the beneficial effects of CP5 would be the similar to those of CP3. Thus, the project would not result in a cumulatively considerable incremental contribution to significant cumulative impacts on socioeconomic resources.

Extended Study Area The adverse effects of CP5 would be the same as those of CP1. With implementation of Mitigation Measure Socio-14 (CP5), adverse effects from CP5 would be fully mitigated because Reclamation would secure replacement water or hydropower during project construction. Therefore, the project would not make a cumulatively considerable incremental contribution to significant cumulative impacts related to the temporary reduction during construction in water or hydropower supplies to the CVP and SWP service areas.

Implementing CP5 would result in less-than-significant impacts on population and housing and also would have beneficial impacts on employment and the labor force, business and industrial activity, and government and finance. Overall, in the extended study area, the beneficial effects of CP5 would be similar to those of CP3. Thus, the project would not result in a cumulatively considerable incremental contribution to significant cumulative impacts on socioeconomic resources.

Chapter 17 Land Use and Planning

17.1 Affected Environment

This chapter describes the affected environment related to land uses and planning for the dam and reservoir modifications proposed under SLWRI action alternatives.

Because of the potential influence of the proposed modification of Shasta Dam and water deliveries over a large geographic area, the SLWRI includes both a primary study area and an extended study area. The primary study area has been further divided into Shasta Lake and vicinity and the upper Sacramento River (Shasta Dam to Red Bluff). The extended study area has been further divided into the lower Sacramento River and Delta and the CVP/SWP service areas (Figure 1-3).

The setting for land uses and planning in the Shasta Lake and vicinity portion of the primary study area consists of the portion of Shasta County north of Shasta Dam. This area encompasses Shasta Lake, lands surrounding the lake, and parts of the Pit River, Squaw Creek, McCloud River, and Sacramento River watersheds. Land use and planning in this area are influenced by land ownership, the presence of rural lakeside communities, and topography.

The setting for land uses and planning in the upper Sacramento River portion of the primary study area consists of the portion of Shasta County south of Shasta Dam and Tehama County. The incorporated cities of Shasta Lake, Redding, Anderson, and Red Bluff, all located along the Interstate 5 (I-5) corridor, establish urban settings in the otherwise rural upper Sacramento Valley. The upper Sacramento Valley is characterized by rolling hills with mountains to the north, east, and west. Land use and planning in this area are influenced by land ownership, historic land use patterns, topography, and population densities.

The land use and planning setting for the extended study area consists of 24 counties downstream from the Red Bluff Pumping Plant and encompasses all areas served by the CVP and the SWP. Land use and planning in the extended study area are influenced by the same factors identified for the upper Sacramento River study area. The type and focus of land use and planning may vary, however, in the large urban areas located in the extended study area.

17.1.1 Land Use

Shasta Lake and Vicinity

Land uses in the Shasta Lake and vicinity portion of the primary study area consist primarily of open space and other land uses that support recreational activities in the Shasta Unit of the Whiskeytown-Shasta-Trinity National Recreation Area (NRA). The Shasta-Trinity National Forest (STNF) manages the Shasta Unit of the NRA. Federally managed lands in the NRA total 235,740 acres, including Shasta Lake; lands held in private ownership total 10,347 acres. The U.S. Department of the Interior, Bureau of Land Management (BLM) manages the Shasta-Chappie Off-Highway Vehicle (OHV) area and other public lands immediately west of Shasta Lake; this area extends south towards Keswick Dam on both sides of the Sacramento River. The Federal lands immediately surrounding Shasta Dam and related facilities are managed by Reclamation. In addition, the California Department of Transportation (Caltrans) manages the I-5 corridor and the Union Pacific Railroad (UPRR) manages the rail corridor that crosses the primary study area (Figure 17-1).

The *Shasta-Trinity National Forest Land and Resource Management Plan* (LRMP) (USFS 1995) specifies several land allocations for National Forest System (NFS) lands managed by the Shasta Lake Ranger District within and adjacent to the Shasta Unit of the NRA. NFS lands in the primary study area are allocated as Late-Successional Reserves (LSR), Managed Late-Successional Areas, and other Threatened, Endangered, or Sensitive Species, Riparian Reserves, Administratively Withdrawn Areas, and Matrix.

LSRs and Administratively Withdrawn Areas each account for 20 percent of the land use designations in the NRA. Riparian Reserves, the largest land use designation in the NRA, are located in areas along rivers, streams, lakes, and wetlands, including the area inundated by Shasta Lake. Riparian Reserves were established to provide connectivity between LSRs and the Matrix throughout the NRA.

Approximately 25 percent of the land managed by the STNF within the boundary of the NRA is designated as either Administratively Withdrawn Areas or Matrix. Lands allocated as withdrawn were identified in the STNF LRMP as management emphasis areas where scheduled timber harvest is precluded. The Matrix consists of other Federal lands outside the categories described above that may be managed for timber or other resource purposes and are not subject to certain standards and guidelines.

STNF LRMP direction for the Shasta Unit of the NRA is to: (1) provide public outdoor recreation opportunities; (2) conserve scenic, scientific, historic, and other values that contribute to public enjoyment; and (3) manage, use, and dispose of renewable natural resources, which will promote, but not significantly impair, public recreation or conservation of scenic, scientific, historic or other values contributing to public enjoyment (36CFR292.11).

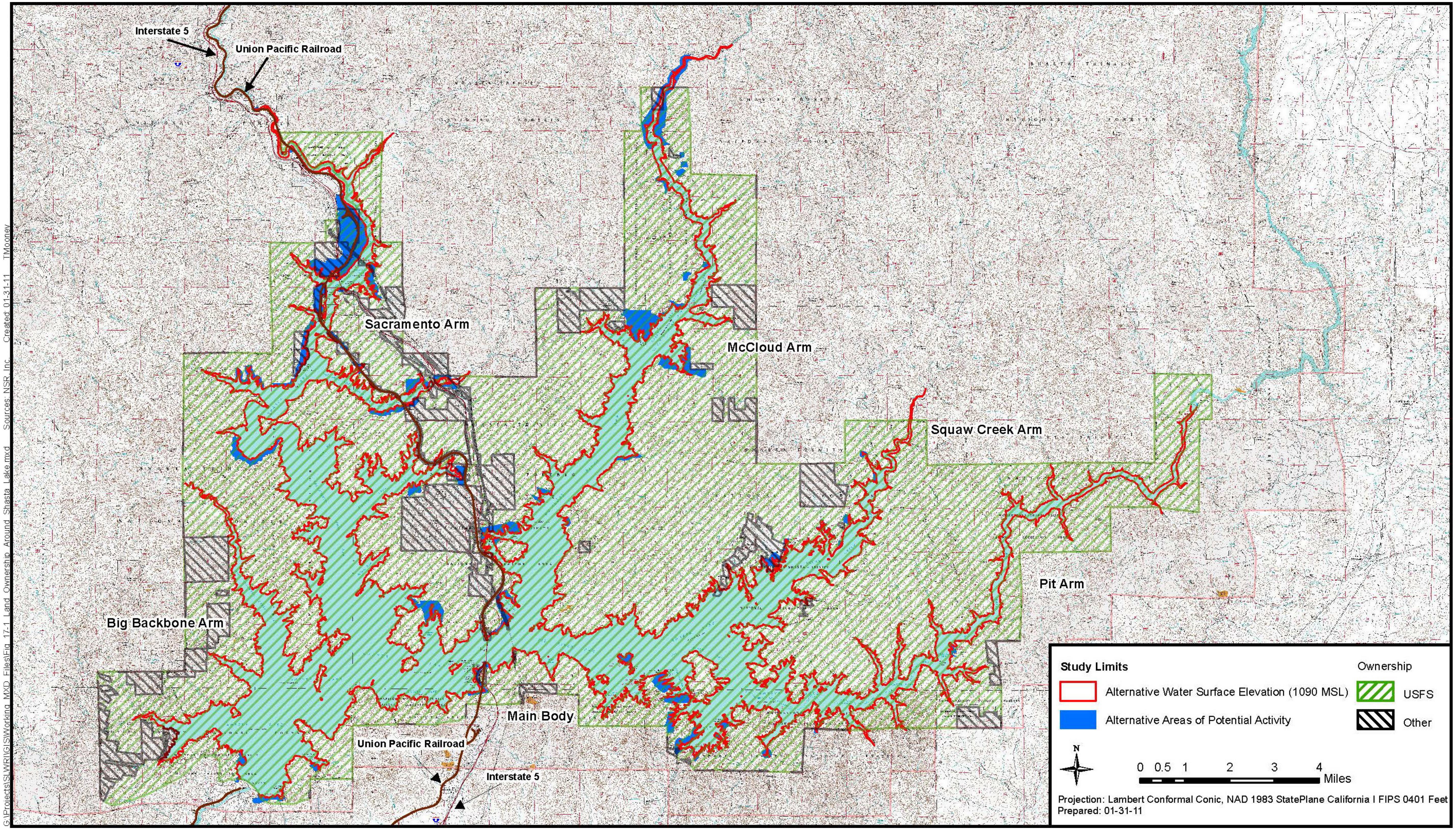


Figure 17-1. Land Ownership Around Shasta Lake

This page left blank intentionally.

Developed recreational and commercial land uses occupy 2 percent of the land managed by the STNF within the Shasta Unit of the NRA. Recreational use in the NRA exceeds 2 million visitor days annually. Water-oriented activities, such as boating, fishing, waterskiing, and houseboating, are the main attractions. Marinas that currently operate on Shasta Lake include Antlers, Sugarloaf, Shasta, Holiday Harbor, Packers Bay, Bridge Bay, Silverthorn, Jones Valley, and Digger Bay. Other recreational land uses include hiking, camping, picnicking, and OHV activities. A planning permit was issued by the STNF to decommission Digger Bay and construct a new marina at Turntable Bay, but the permit was not exercised and has since been revoked.

Commercial land uses in the NRA include resorts, marinas, campgrounds, restaurants, motels, grocery stores, and service stations. Resorts are sometimes operated as stand-alone entities, but are more typically operated in conjunction with a marina. Some resorts on Shasta Lake must move their docks substantial distances from their land-based facilities during periods of low water levels.

USFS manages recreation residence tracts at Salt Creek, Silverthorn, Campbell Creek, and Didallis Creek; these tracts combined contain 160 privately owned cabins on NFS lands. USFS policy is to manage these tracts and residences for individual recreational use and to keep the areas as close as possible to their natural state. Only minimal improvements are permitted, and structures must blend into the natural environment.

Mining and grazing do not take place in the NRA. There are no grazing permits authorized for the Shasta Unit of the NRA, primarily because of a lack of suitable range. Federal lands in the NRA, except those with valid existing rights, were withdrawn from mineral entry by the legislation that created the NRA. Reclamation and USFS conducted validity determinations on most of the claims existing at that time and contested the majority of them based on the absence of a valid discovery. There were five claims in the Shasta Unit of the NRA (See Page II-12 of the NRA Guide, STNF 1996) that predate the withdrawal; these claims have not been developed and are considered closed by the USFS. The lands covered by these claims remain open to mineral leasing. Hard rock minerals in the NRA are available for prospecting, exploration, and development under solid mineral leasing regulations (43 Code of Federal Regulations (CFR) Subpart 3583). Authorization for this land use requires permits and leases subject to approval by the Secretary of Agriculture and terms and conditions of the USFS to protect the values of the NRA.

There are two Inventoried Roadless Areas (IRA) that are managed by the STNF within and adjacent to the NRA boundary. Geographic information system (GIS) information provided by the USFS indicates that the boundaries of these IRAs coincide with the current full-pool elevation of Shasta Lake. The Backbone IRA encompasses 11,464 acres and is adjacent to the shoreline of Shasta Lake at two locations; 1.9 miles along the Big Backbone Arm and 5.8 miles along the Sacramento Arm. The Devils Rock IRA encompasses 16,207 acres on the STNF; 12.9 miles of this IRA are adjacent to the Pit Arm of Shasta Lake.

Land uses on privately owned lands in the NRA generally consist of commercial, recreational, and residential land uses associated with the NRA. Approximately 20 percent of the privately held lands in the NRA are developed. Commercial development consists primarily of service industries supporting residents and recreational visitors.

Residential land uses are typically characterized as low density and rural. Established small communities along Shasta Lake include Lamoine, Lakehead, Lakeshore, and Sugarloaf, which are located on the Sacramento Arm of Shasta Lake. Farther south is the residential community of O'Brien, which is located between the Sacramento and McCloud arms near I-5.

The McCloud River, which flows into Shasta Lake in the primary study area, is eligible for listing as wild and scenic under the Federal Wild and Scenic Rivers Act (Federal WSRA). In addition, although it is not State of California (State)-listed as wild and scenic, the McCloud River receives certain protections under the California Public Resources Code (PRC), Section 5093.542, established through enactment of the California Wild and Scenic Rivers Act, as amended (Sections 5093.50–5093.70). The effects of the proposed enlargement of Shasta Lake on the McCloud River are discussed in Chapter 25, "Wild and Scenic River Considerations for McCloud River," of this EIS.

The Sacramento River above Shasta Dam was also identified as eligible for listing as wild and scenic under the Federal WSRA in Appendix E to the Final EIS for the STNF LRMP. The USFS acknowledged this segment was eligible (Recreation) based on the presence of four outstandingly remarkable values (ORV); Cultural/Historical, Fisheries, Geology, Visual Quality/Scenery. The limited amount of land managed by the STNF along this segment (14 percent of the segment corridor) precluded the USFS decision to move the eligibility process forward; the agency determined it did not have the ability to manage these ORVs.

Upper Sacramento River (Shasta Dam to Red Bluff)

Land uses in the upper Sacramento River area consist of urban, residential, municipal and industrial, and agricultural uses. Urban development is located in the valley and is concentrated along the transportation corridors provided by I-5, State Route 273, and the UPRR. Incorporated cities located in the valley along I-5 in the upper Sacramento River study area are the cities of Shasta Lake, Redding, Anderson, and Red Bluff. Cottonwood, an unincorporated community located along the I-5 corridor, also has residential and commercial development.

Small rural communities characterize development patterns between Cottonwood and Lakehead on either side of the I-5 corridor. Many of these communities have their origins in the early settlement of Shasta County and

Tehama County, as evidenced by the agriculture, grazing, and timber operations typical of the upland areas. These communities usually consist of small community centers surrounded by vast tracts of fields and forest that are dotted with home sites (Shasta County 2004).

The northern, western, and eastern portions of Shasta County are relatively uninhabited because the lands in these areas are managed by USFS for timber, wildlife, and wilderness uses. Lands managed by USFS in the western and southeastern portions of Tehama County are also relatively uninhabited.

The National Park Service manages lands in the upper Sacramento River study area, including the Whiskeytown Unit of the NRA, west of Keswick, and Lassen Volcanic National Park, in the northeastern corner of Tehama County. The BLM manages the 12,194-acre Sacramento River Bend Management Area on the east side of the Sacramento River northeast of Red Bluff.

The National Rivers Inventory (NRI) identified three segments of the Sacramento River that are eligible for inclusion in the national Wild and Scenic River System that could be affected by the proposal to raise Shasta Dam. No segments of river have been designated as a wild and scenic river under Federal law in either the Sacramento or McCloud River systems.

Three segments lie on the Sacramento River below the Shasta Dam. These were evaluated in the BLM's Redding Resource Management Plan (RMP: A-16) and are briefly described in Table 17-1.

Table 17-1. Sacramento River – Eligible Segments From NRI and BLM RMP

River	Potentially Affected Eligible Segment	ORVs	Responsible Federal Agency
Sacramento	Below Shasta Dam, Arnold Bend above Colusa to Red Bluff Diversion Dam.	Recreation and Fishing	Bureau of Land Management; US Fish and Wildlife Service (Corning to Colusa)
Sacramento	Below Shasta Dam, Interstate Highway 5 bridge crossing immediately north of Red Bluff to Interstate Highway 5 bridge crossing at Anderson.	Scenery, Recreation, Fishing, Wildlife and Other Values.	Bureau of Land Management
Sacramento	Below Shasta Dam, Balls Ferry Bridge to gaging station below Sevenmile Creek	Scenery, Recreation, Fishing, Heritage	Bureau of Land Management

Key:
BLM = Bureau of Land Management
NRI = National Rivers Inventory
ORV = outstandingly remarkable value
RMP = Resource Management Plan

Lower Sacramento River and Delta

Land uses in the extended study area vary greatly because of differences in population, economy, and environment. Land uses in the Sacramento Valley are principally agricultural and open space, with urban development focused around the State capital in the Sacramento metropolitan area. The primary private land use in the region is agriculture. Urban development has occurred along major highway corridors, primarily in Sacramento, Placer, El Dorado, Yolo, Solano, and Sutter counties, and has caused some agricultural land to be taken out of production. For those lands that remain agricultural, soil conditions allow a wide variation in the types of crops grown.

The American River flows into the Sacramento River downstream from Nimbus Dam; its watershed is included in the lower Sacramento River and Delta portion of the extended study area. Two sections of the American River, the North Fork American River from its source in the Sierra Nevada to the Iowa Hill Bridge near Colfax and the lower American River from Nimbus Dam to the river’s confluence with the Sacramento River in the City of Sacramento, are listed as wild and scenic under the Federal WSRA and the State PRC.

The listed segment of the North Fork American River is designated as a wild river under the Federal WSRA and the State PRC. The listed segment is above any regulated reaches and is not under the control of the CVP or SWP. The downstream end of the listed segment is more than 70 river miles and 50 air miles upstream from the confluence with the Sacramento River and is thus too far away to be affected by any hydraulic changes in the Sacramento River.

The lower American River is regulated by Folsom Dam, which is approximately seven miles upstream from Nimbus Dam. Both Shasta Dam and Folsom Dam release water in accordance with their operational requirements, including releases to maintain water quality for fisheries, municipal use, and agricultural use, and for exports to the San Joaquin Valley. Both dams have operational requirements for the sections of the Sacramento and lower American rivers above their confluence, and they also have shared operational requirements for the Sacramento River and Delta below the confluence. Therefore, operational changes at one dam could require operational changes at the other. For example, reduced releases from Shasta Dam could require increased releases from Folsom Dam to meet flow requirements in the lower Sacramento River and Delta.

The lower American River is designated as a recreational river under the Federal WSRA and the PRC. Fishing and boating, including rafting and canoeing, are the primary recreational activities on the river. In addition, much of the lower American River's south shore is part of the American River Parkway. Joggers, bicyclists, walkers, and other users take advantage of the riverside trails and beaches of this extensive park system.

As shown on Table 17-1, one segment of the Sacramento River is listed as eligible for consideration under the Federal WSRA. The USFWS manages several wildlife refuges adjacent to this segment of the river between Corning and Colusa, California.

CVP/SWP Service Areas

The CVP, operated by Reclamation, is the largest water storage and delivery system in California, covering 29 of the State's 58 counties. Most of the CVP service area is in the Central Valley, and about 90 percent of the south-of-Delta contractual delivery is for agricultural uses (Reclamation 2007).

Most of the population of the CVP service area is concentrated within urban areas. The CVP service area includes various municipal and industrial water contractors and water districts that serve portions of the Sacramento and Stockton metropolitan areas and the San Francisco Bay Area. Outside these population centers, most of the CVP service area is rural, with irrigated agriculture the predominant land use and economic driver (Reclamation 2007).

SWP water is delivered to contracting agencies in Northern California, the San Francisco Bay Area, the Central Coast, San Joaquin Valley, and Southern California.

Land uses in the CVP/SWP service areas vary and include agricultural, municipal and industrial, commercial, open space, grazing, and timber production.

17.1.2 Planning

Shasta Lake and Vicinity

Federal Land Use Planning Federal lands are not subject to county or city general plans. Land use planning direction for the NRA is guided by Public Law 89-336 and associated regulations (including 36 CFR Part 292, Subpart B), USFS Directives, and management direction found in the STNF LRMP. As a result of more recent Congressional action, BLM manages all public lands west of the NRA including the Chappie-Shasta OHV Area. BLM also manages public lands along the Sacramento River corridor downstream from Shasta Dam to Red Bluff.

Shasta-Trinity National Forest Land and Resource Management Plan The STNF LRMP is based on three broad management strategies: preservation, biodiversity, and sustainable development for people. The objectives of the STNF LRMP are to:

- describe the desired conditions of NFS lands and resources;
- identify strategies to maintain or achieve those conditions;
- identify land areas as generally suitable or unsuitable for various uses;

- identify the guidelines for projects and activities; and
- identify areas with special or unique characteristics.

Projects and activities must be consistent with the applicable plan components. The STNF LRMP provides management direction at four integrated levels: (1) forest-wide direction, (2) land allocations and standards and guidelines, (3) management prescription direction, and (4) management area direction.

In addition to the land allocations described in the preceding section (LSRs, Riparian Reserves, Administratively Withdrawn Areas, and Matrix), there are a number of goals and associated standards and guidelines applicable to the SLWRI project with respect to NFS lands in the primary study area. Goals and associated standards and guidelines that describe the desired future condition of the STNF include:

- Lands
  - Plan for long-range land ownership adjustments that support resource objectives. Within and adjacent to the NRA, acquire available, undeveloped private lands needed to fulfill the management goals and objectives of the recreation resource program. Acquire those parcels of land that are specifically needed: (a) for public development; (b) to protect major visual resource values; (c) to protect prime wildlife habitat; and (d) to preserve important cultural values and make them available for public enjoyment.
  - Provide for continued use and new development of hydroelectric facilities.
  - During the project planning phase, consider the need for construction of trails, roads, and/or recreational facilities.

Seven land allocations apply to the STNF: Congressionally Reserved Areas (Wilderness Areas), LSRs, Managed Late-Successional Areas Administratively Withdrawn Areas, Riparian Reserves, Matrix, and Adaptive Management Areas (USFS 1995). There are no Congressionally Reserved Areas and Adaptive Management Areas in the primary study area so these allocations are not considered in this analysis.

The STNF LRMP requires each type of land use to be managed in accordance with applicable management prescriptions and the respective standards and guidelines pertaining to both land allocations and unique management areas. Lands allocated as LSRs, for example, have specific management objectives and standards and guidelines for air quality, biological diversity, fire and fuels, etc. The applicable management prescriptions for the four land allocations in the primary study are discussed below.

- **Late-Successional Reserves, Managed Late-Successional Areas, and other Threatened, Endangered, or Sensitive Species –** LSRs have been established to protect and enhance conditions of late-successional and old-growth forest ecosystems and to ensure the support of related species, including the northern spotted owl. The applicable management prescription is:
  - Provide special management for Late Successional Reserves and Threatened, Endangered and Selected Sensitive Species that are primarily dependent on late seral stage conditions.
- **Administratively Withdrawn Areas –** These areas are identified in the STNF LRMP and include recreation and visual areas, backcountry, and other areas where management emphasis precludes scheduled timber harvesting. The applicable management prescriptions are:
  - **Unroaded Non-Motorized Recreation –** Provide for semi-primitive non-motorized recreation opportunities in unroaded areas outside existing wilderness areas while maintaining predominantly natural-appearing areas with only subtle modifications.
  - **Limited Roaded Motorized Recreation –** Provide for semi-primitive motorized recreation opportunities while maintaining predominantly natural-appearing areas with some modifications.
  - **Roaded, High Density Recreation –** Provide areas that are characterized by a substantially modified natural environment.
  - **Special Area Management –** Provide for protection and management of special interest areas and research natural areas.
  - **Heritage Resource Management –** The primary theme of this prescription is to protect designated cultural resource values, interpret significant archaeological and historical values for the public, and encourage scientific research of these selected properties.
- **Riparian Reserves –** Provide an area along streams, wetlands, ponds, lakes, and unstable and potentially unstable areas where riparian-dependent resources receive primary emphasis. The applicable management prescription is:
  - **Riparian Management –** Maintain or enhance riparian areas, wildlife and fisheries habitat, and water quality by emphasizing streamside and wetland management.

- **Matrix –** Includes Federal lands outside the categories of the designated areas listed above. There are no Matrix lands in the NRA. Matrix lands are where most timber harvest would occur and where standards and guidelines are in place to ensure appropriate conservation of ecosystems as well as provide habitat for rare and lesser known species. The applicable management prescriptions are:
  - **Roaded Recreation –** Provide for an area where there are moderate evidences of the sights and sounds of humans.
  - **Wildlife Habitat Management –** The primary purpose of this prescription is to maintain and enhance big game, small game, upland game bird, and nongame habitat to provide adequate hunting and viewing opportunities.

The STNF LRMP provides another more specific layer of land use planning guidance for the NRA: the *Management Guide: Shasta and Trinity Units of the Whiskeytown-Shasta-Trinity NRA* (USFS 2014). The Land Use and Ownership section of this document provides the following guidance for NRA lands managed by the STNF:

- Those private lands that would enhance outdoor recreation opportunities and/or the conservation of scenic, scientific, historic, and other values contributing to the public enjoyment of the NRA should be acquired as opportunities arise.
- Land exchanges will be pursued in accordance with the Forest Land Adjustment Guide. Lands directly adjacent to the shoreline will have the highest priority.
- Lands with significant known pollution sources arising from a history of mining discharge will not be acquired.
- Coordination will take place with Shasta County to allow those private land developments and resource production proposals that will maintain or enhance NRA values, and to disallow or phase out private land uses that detract from those values.
- Coordination will take place with county, State, and other Federal agencies on development, management, and regulatory oversight of recreation opportunities and facilities to ensure consistency with NRA objectives.
- Planning will take place with owners and managers of travel and utility corridors through the NRA (railroad, highway, and major power lines) to minimize the visual impacts of these corridors on the aesthetic value of the NRA.

On January 12, 2001, the Department of Agriculture adopted the rule that established prohibitions on road construction, reconstruction, and timber harvest in IRAs because they have the greatest likelihood of altering and fragmenting landscapes, resulting in immediate, long-term loss of IRA values and characteristics. Subsequently, the STNF finalized the boundaries of IRAs, including two areas adjacent to the Shasta Unit of the NRA; Backbone and Devils Rock.

The STNF coordinates with Shasta County to ensure that private development in the NRA maintains or enhances NRA values through local zoning regulations.

Mendocino National Forest Land and Resource Management Plan The management direction, objectives, and standards and guidelines of the Mendocino National Forest LRMP are applicable to an isolated 488-acre parcel of land managed by the Mendocino National Forest along the east bank of the Sacramento River in the general vicinity of the decommissioned Red Bluff Diversion Dam. In addition to a developed recreation area (Sycamore Campground), this parcel provides river access, habitat for special-status species and undeveloped open space used by the public for hiking, biking, and other recreational activities.

U.S. Bureau of Land Management Resource Management Plan As a result of Congressional action, BLM manages all public lands west of the NRA including the Chappie-Shasta OHV Area. BLM also manages public lands along the Sacramento River corridor downstream from Shasta Dam to Red Bluff. The primary study area is within the boundary of the Northern California District; the Central California District manages public lands throughout most of the extended study area. The resource management plans (RMP) of three BLM field offices: Redding, Ukiah, and Mother Lode (BLM 2006) are applicable to most of the public lands within both the primary and extended study areas. The purpose of BLM’s RMPs is to provide an overall direction for managing and allocating public resources in each planning area. Planning issues addressed in the RMPs include land tenure adjustments, such as land acquisition, exchange, and sale; recreation management; access; and forest management, including harvesting, herbicide use, and special-status species.

BLM’s Redding RMP (BLM 1993) provides guidance for the management of cultural resources, fire, grazing, minerals, vegetation, water quality, wildlife and fish habitats, and other resources and issues in Shasta County. The RMP was amended by the 1994 Record of Decision for the *Northwest Forest Plan* (Final Supplemental EIS for Amendments to USFS and BLM Planning Documents within the Range of the Northern Spotted Owl). This amendment required preparation of a Watershed Analysis before initiating BLM activities. Under the respective RMPs, as amended by the *Northwest Forest Plan*, BLM, like USFS, is also required to ensure that projects are consistent with the Aquatic

Conservation Strategy and other management direction specified in the 1994 Record of Decision for the *Northwest Forest Plan*.

The Redding RMP governs land use on BLM lands, including lands in the Sacramento River Management Area. The goal of the lands program of the Redding Field Office is to transform the scattered land base of the Redding Resource Area into consolidated resource management units to meet the needs of public land users. The RMP includes the following management guidance for its land program:

- All lands identified for transfer to another agency or qualified organization are for long-term stewardship by the receiving entity.

- All land acquisitions will be through exchange, purchase, or donation. Acquisitions will be from willing sellers for available unimproved property. In all acquisitions, BLM will strive to gain the local support and understanding for the action.

- All land identified for disposal through exchange, Recreation and Public Purposes Act transfer, or sale meets the criteria set forth in the Federal Land Policy and Management Act of 1976.

- Land use authorizations (rights-of-way, leases, permits) will continue to be issued on a case-by-case basis and in accordance with decisions established in the RMP. Applications for land use authorizations which reduce the marketability of an exchange parcel will not be authorized.

- Rights-of-way will be issued to promote the maximum utilization of existing rights-of-way routes, including joint use whenever possible.

County Land Use Planning Land-use planning on non-Federal land is under the jurisdiction of local governments in California. All cities and counties in California are required by the State to adopt a general plan establishing goals and policies for long-term development, protection from environmental hazards, and conservation of identified natural resources (California Government Code Section 65300). General plans lay out the pattern of future residential, commercial, industrial, agricultural, open-space, and recreational land uses on non-Federal land within a community. To facilitate implementation of planned growth patterns, general plans identify goals and/or policies to establish land use patterns.

Local governments implement general plans by adopting zoning, subdivision, grading, and other ordinances. Zoning ordinances identify specific types of land uses that may be allowed on a given site and establish specific development standards. Zoning regulations vary from jurisdiction to jurisdiction. However, typical standards promulgated in zoning ordinances include the siting of structures relative to parcel boundaries, architectural design (including height limitations), and the percentage of building coverage allowed relative to the overall square footage of a parcel.

The *Shasta County General Plan* (Shasta County 2004) provides planning guidance for privately owned land in Shasta County. Land use directives are provided in the form of goals, policies, objectives, standards, and guidelines. The following land uses described in the general plan are present in the Shasta Lake and vicinity portion of the primary study area:

- **Rural Residential –** Encompasses areas that receive minimal urban services, usually in or near a rural community center and areas with no urban services that are located in areas of the county characterized by one or more of the following conditions:
  - Severe limitations on septic tank use
  - Uncertain long-term availability of water
  - Proximity to lands categorized as timber, grazing, or crop lands
  - Remoteness from urban, town, and rural community centers
  - Extreme wildland fire hazard
  - Inaccessibility via county-maintained roads
- **Existing Residential –** This designation may be applied to residential areas that existed before 1984 and that do not fit the land use designation or density applied to surrounding properties.
- **Mixed Use –** This category recognizes that in a rural setting the strict segregation of different land use types, which is typically found in urban environments, is neither necessary nor practical. At this scale, conflicts that may result from the intermixing of land uses may be addressed by Shasta County zoning and development standards related to screening setbacks and architectural design.
- **Commercial Recreational –** This designation provides opportunities for the development of privately owned lands characterized by the natural environment for the purpose of providing commercial recreation activities that use and provide for the enjoyment of the natural environment. Examples of commercial recreation include campgrounds, fishing and hunting clubs, dude ranches, boating facilities, and recreational vehicle parks. Other uses such as a restaurant or small grocery store may be permitted when accessory to, supportive of, and compatible with the recreation activity.
- **Natural Resources Protection**

- **Community Parks** – Provides for large-scale community recreation facilities
- **Habitat** – Provides for protection of significant wildlife habitat resources

Shasta County land use actions and decisions on non-Federal land in the NRA are subject to STNF review and approval pursuant to 36 CFR Part 292, Subpart B.

Upper Sacramento River (Shasta Dam to Red Bluff)

Land use planning in the upper Sacramento River area consists of general plans adopted by Shasta and Tehama counties and the cities of Shasta Lake, Redding, Anderson, and Red Bluff. BLM lands in this area are managed in accordance with the Redding RMP, discussed in Section 17.2, "Regulatory Framework."

Local Land Use Planning

Shasta County The *Shasta County General Plan* (2004) designates the following land uses along the Sacramento River from Shasta Dam south to the Tehama County line:

- Rural residential
- Greenway
- Habitat resource
- Natural habitat
- Agricultural – cropland
- Agricultural – small-scale crops, grazing
- Mineral resources

Tehama County The *Tehama County General Plan Update 2009–2029* (2009) designates the following land uses along the Sacramento River from the Shasta County line in the north to Red Bluff:

- Habitat Resources
- Valley Floor Agriculture
- Public Facility
- Rural Residential–Small Lot
- Suburban Residential

City of Shasta Lake The *City of Shasta Lake General Plan* was adopted in 1999. The general plan designates the following land uses along Shasta Dam Boulevard, the primary roadway leading up to Shasta Dam:

- Community park
- 100-year floodplain
- Public facilities
- Commercial
- Mixed use
- Rural residential (1 unit/2 acres, 1 unit/5 acres)
- Suburban residential (3 units/acre)
- Urban residential (10 units/acre)
- Urban residential – High (20 units/acre)

City of Redding The City of Redding adopted an updated general plan in 2000 (City of Redding 2000). The general plan designates the following land uses along the Sacramento River within the city limits and sphere of influence:

- Greenway
- Park, Park-Golf
- Public Facility; Public Facility-School
- Recreational
- General Office
- General Commercial
- Neighborhood Commercial
- Residential (2–3.5, 3.5–6, 6–10 units/acre)
- Critical Mineral Resource Overlay
- Mixed Use Neighborhood Overlay

City of Anderson The City of Anderson released its updated general plan in May 2007 (City of Anderson 2007). The general plan designates the following land uses along the Sacramento River within the city limits and sphere of influence:

- Commercial
- Industrial
- Public/Quasi-Public
- Medium-Density Residential
- Rural Residential/Rural Estate

City of Red Bluff The City of Red Bluff most recently amended its General Plan Land Use Element in 1993; the city is currently updating this plan. The general plan designates the following land uses along the Sacramento River within the city limits and sphere of influence:

- Primary Floodplain
- Exclusive Agriculture
- General Commercial
- Central Business Districts
- Single-Family Residential
- General and Neighborhood Apartment Districts
- General Industrial
- Public Agency District
- Park

Lower Sacramento River and Delta

The lower Sacramento River and Delta are within the planning jurisdiction of Butte, Colusa, Contra Costa, Glenn, Sacramento, Solano, Sutter, Yolo, and Yuba counties. The largest cities in this region are Antioch, Chico, Davis, Fairfield, Martinez, Marysville, Pittsburg, Sacramento, Vacaville, Vallejo, West Sacramento, and Woodland. Each of these entities currently has adopted general plans and zoning ordinances. Land use planning documents are adopted by Federal agencies for federally managed lands in the lower Sacramento River and Delta areas.

CVP/SWP Service Areas

The CVP extends from the Cascade Range near Redding in the north to the Tehachapi Mountains near Bakersfield in the south. The CVP serves farms, homes, and industry in California's Central Valley as well as major urban centers in the San Francisco Bay Area. SWP contractors are in the southern San Joaquin Valley, Central Coastal area, and Southern California. The CVP and SWP service areas include portions of the primary and extended study areas. CVP water irrigates more than 3 million acres of farmland and provides drinking water to nearly 2 million consumers. SWP deliveries are 70 percent urban and 30 percent agriculture, serving 20 million Californians and more than 600,000 irrigated acres, respectively. Each of the counties and incorporated cities in the CVP and SWP service areas has adopted general plans and zoning ordinances. Federally managed lands in the service areas are managed in accordance with land use and planning documents similar to the STNF LRMP and BLM's RMP, and military installations located in the service areas have their own planning processes.

17.2 Regulatory Framework

17.2.1 Federal

Federal land use policies apply only to actions on, or affecting the uses of, Federal lands. Federal lands in the primary study area consist of the following:

- National Forest lands managed by STNF around Shasta Lake
- Lands along the Sacramento River just south of Shasta Dam managed by Reclamation
- Lands managed by BLM along the Sacramento River south of Shasta Dam as far downstream as Red Bluff

Entry upon or use of these Federally administered lands would require approval from the appropriate Federal entity(ies).

Federal Land Policy and Management Act

The Federal Land Policy and Management Act was enacted to change the Federal public lands policy from disposal to retention. The act directs Federal agencies to apply land use principles that emphasize conservation; these include the principles of multiple use and sustained yield land management policies. The Federal Land Policy and Management Act consolidated and articulated BLM's management responsibilities and applies primarily to this Federal land management agency. Title V of the Federal Land Policy and Management Act also granted the Secretary of the Interior and the Secretary of Agriculture the authority to issue rights-of-way for various uses, including reservoirs.

Code of Federal Regulations

USFS personnel administer their responsibilities for regulating use and protecting National Forest lands under Title 36 of the CFR and sections of titles 16, 18, and 21. Public services directives from the code are integrated into the STNF LRMP and include the following topics: fire and fuels management, facilities management, law enforcement, and land management.

Shasta-Trinity National Forest Land and Resource Management Plan

The STNF LRMP is a forest-wide land use plan developed to guide resource management on STNF lands. Six broad categories are used to define management strategies. The management strategies (known as land allocations) are implemented through management prescriptions that provide specific standards and guidelines for forest resource management (USFS 1995).

Management Guide for the Shasta and Trinity Units of the Whiskeytown-Shasta-Trinity National Recreation Area

The 2014 NRA *Management Guide: Shasta and Trinity Units of the Whiskeytown-Shasta-Trinity NRA* (USFS 2014) contains management guidance intended to achieve or maintain desired conditions for the NRA. The document provides specific information about current conditions in the NRA, desired future conditions for the NRA, and management recommendations for the NRA. STNF is responsible for administering the Shasta and Trinity units of the NRA.

Mendocino National Forest Land and Resource Management Plan

The Mendocino LRMP is a forest-wide land use plan developed to guide resource management on NFS lands. Six broad categories are used to define management strategies. The management strategies (known as land allocations) are implemented through management prescriptions that provide specific standards and guidelines for forest resource management (USFS 1995).

U.S. Bureau of Land Management Resource Management Plans

BLM manages a number of public lands adjacent to the Sacramento River corridor downstream from Shasta Dam. The study area falls under two BLM districts (Northern California and Central California) and the RMPs of three BLM field offices: Redding, Ukiah, and Mother Lode (BLM 2006). The purpose of BLM's RMPs is to provide overall direction for managing and allocating public resources in each planning area.

BLM's Redding RMP (BLM 1993) provides guidance for the management of cultural resources, fire, grazing, minerals, vegetation, water quality, wildlife and fish habitats, and other resources and issues in Shasta County. The RMP governs land use on BLM lands, including lands in the Sacramento River Management Area. Planning issues addressed in the RMP include land tenure adjustments, such as land acquisition, exchange, and sale; recreation management; access; and forest management, including harvesting, herbicide use, and special-status species.

The RMP was amended by the 1994 Record of Decision for the *Northwest Forest Plan* (Final Supplemental EIS for Amendments to USFS and BLM Planning Documents within the Range of the Northern Spotted Owl). This amendment required preparation of a Watershed Analysis before initiating BLM activities. As a party to the *Northwest Forest Plan*, BLM, like USFS, is also required to ensure that projects are consistent with the Aquatic Conservation Strategy.

Federal Wild and Scenic Rivers Act

The Federal WSRA, enacted in 1968, established the National Wild and Scenic Rivers System "to preserve rivers with outstanding natural, cultural, and recreational values in a free-flowing condition for the enjoyment of present and future generations." To be eligible for inclusion in the system, a river must be free-flowing and exhibit ORVs. Free-flowing means "existing or flowing in a natural condition without impoundment, diversion, straightening, rip-rapping, or other modification of the waterway" (16 USC Section 1286). ORVs are scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values (16 USC Section 1271). Depending on the specific attributes of a river, it may be designated as "wild," "scenic," or "recreation." Different segments of a single river can receive different designations; in other words, some segments can be designated wild, some scenic, and some recreation or combinations of these designations. Recreation rivers are defined as “rivers or sections of rivers that are readily accessible by road or railroad, that may have some development along their shorelines, and that may have undergone some impoundment or diversion in the past” (16 USC Section 1286).

State-designated rivers may be added to the Federal system upon the request of the state’s governor and the approval of the Secretary of the Interior (16 USC Section 1286). Two sections of the American River were added to the Federal system in 1981 under this method. These sections are the lower American River from Nimbus Dam to the river’s confluence with the Sacramento River and the North Fork American River from its source to the Iowa Hill Bridge. The North Fork section is located above Nimbus, Folsom, and Lake Clementine dams many miles upstream from the confluence with Sacramento River. The North Fork is not regulated by Folsom Dam and would not be affected by hydraulic changes in the Sacramento River. The lower American River is designated as a recreational river.

Adding state rivers to the Federal system under (16 USC Section 1286) does not require the approval of the Legislature or Congress. State rivers added to the Federal system under this section are to be managed by the state.

17.2.2 State

California Public Resources Code, Division 6

PRC Division 6 grants the State Lands Commission (SLC) jurisdiction over 4.5 million acres of land held in trust for Californians. SLC’s jurisdiction includes a 3-mile-wide section of tidal and submerged land adjacent to the coast and offshore islands, including bays, estuaries, and lagoons. It also includes the waters and beds of more than 120 rivers, lakes, streams, and sloughs. The State holds these lands for the public trust purposes of water-related commerce, navigation, fisheries, recreation, and open space. SLC may grant dredging permits and issue land use leases for activities within its jurisdiction. SLC does not have a comprehensive use plan for these lands but manages them according to State and Federal laws and regulations. In the primary study area, SLC’s jurisdiction includes areas along the Sacramento River north of Red Bluff.

California Fire Plan

The *California Fire Plan* was prepared by the State Board of Forestry and the California Department of Forestry and Fire Protection to provide a comprehensive strategy for wildland fire protection and prevention in California. The plan provides recommendations for fire-safe land use planning. Preventive measures include using fire-resistant building materials, maintaining a defensible space around structures, vegetation management, and infrastructure planning.

Water Quality Control Plan

The *Water Quality Control Plan for the Sacramento River and San Joaquin River Basins* provides water quality objectives to protect beneficial uses of designated rivers and streams. *Water Quality Control Plan for the Sacramento River and San Joaquin River Basins* objectives are incorporated into county and city general plans, zoning ordinances, and subdivision ordinances.

California Public Resources Code, Sections 5093.50–5093.70

PRC Sections 5093.50–5093.70 were established through 1972 enactment of the State Wild and Scenic Rivers Act, which was subsequently amended on several occasions, to preserve certain rivers that possess extraordinary scenic, recreational, fishery, or wildlife values in their free-flowing state. The PRC identifies, classifies, and provides protection for specific rivers or river segments, as approved by the Legislature. Rivers or river segments that are specifically identified and classified in the PRC compose the State Wild and Scenic Rivers System. As described in PRC Section 5093.50, rivers or river segments included in the State system must possess “extraordinary scenic, recreational, fishery, or wildlife values”; however, the PRC does not define what constitutes “extraordinary.”

Depending on the specific conditions of a river, it may be designated as “wild,” “scenic,” or “recreation.” Different segments of a single river can receive different designations; in other words, some segments can be designated wild, some scenic, and some recreation or combinations of these designations. Recreation river segments are readily accessible by road or railroad, may have some development along their shorelines, and may have been impounded or diverted in the past (PRC Section 5093.53).

With its initial passage, the State system protected segments of eight rivers, including two sections of the American River. These sections include the lower American from Nimbus Dam to its confluence with the Sacramento River and the North Fork from its source to the Iowa Hill Bridge. The North Fork section is located above Nimbus, Folsom, and Lake Clementine dams many miles upstream from the confluence with Sacramento River. The North Fork is not regulated by Folsom Dam and would not be affected by hydraulic changes in the Sacramento River. The lower American is designated as a recreational river.

17.2.3 Regional and Local

Shasta County General Plan

The *Shasta County General Plan* (2004) guides land use planning on non-Federal land for Shasta County through 2025. The Community Organization and Development Pattern element of the *Shasta County General Plan* establishes policies related to the organization and relationships of the community types present in Shasta County, the living environments these communities offer, and the locations of development in relation to these communities. These policies were developed to maintain and enhance the quality of their environments. The Community Organization and Development Pattern element includes several objectives that influence land use decisions in the project study area:

- To promote a development pattern that will accommodate, consistent with the other objectives of the plan, the growth that will be experienced by Shasta County
- To guide development in a pattern that will provide opportunities for present and future county residents to enjoy the variety of living environments that currently exist within the county
- To guide development in a pattern that will respect the natural resource values of county lands and their contributions to the county's economic base
- To guide development in a pattern that will minimize land use conflicts between adjacent land users
- To recognize that the major economic resources for achieving the development pattern will come from the private sector, rather than government, and that the general plan, as the expression of community values, will guide the use of these resources

Tehama County General Plan

The *Tehama County General Plan Update 2009–2029* is used to guide future development in unincorporated areas of the county. The Land Use element of the General Plan Update establishes the goals, policies, and implementation measures that will help guide the growth and development of Tehama County for the next 20 years. This element also contains the General Plan Land Use Map, which delineates those areas of the county where future residential development of varying densities and nonresidential growth is anticipated or will be directed (Tehama County 2009).

City of Shasta Lake General Plan

The planning boundaries for the *City of Shasta Lake General Plan* are within the Shasta Lake and vicinity study area, north of Keswick Dam, east of the Sacramento River, and west of I-5. This general plan was adopted in 1999 and is intended to guide land use planning within the city through the Year 2020 (City of Shasta Lake 1999). The following statement from the Land Use element of the general plan identifies some of the concerns surrounding land use decisions within the City of Shasta Lake:

> *The Land Use Element and the Land Use and Circulation Map constitute the physical framework for the general plan, which designates the proposed location, distribution, and extent of land uses. Land use was a specific area of concern identified as*

> *being key to the development of the City of Shasta Lake. Some of the major issues identified included an evaluation and establishment of urban, rural, and urban reserve boundaries. This was accomplished by identifying areas that currently lack infrastructure that would be required to develop in an orderly manner through the development of Area Plans.*

City of Redding General Plan

The planning boundaries for the *City of Redding General Plan* encompass areas within the city limits and the urban growth boundary. This plan was adopted in 2000 and is intended to guide land use planning through the year 2020 (City of Redding 2000). The Community Development and Design element of the general plan states the following about the role and effects of land use policies:

> *Land use policies and the General Plan Diagram affect every property in the City. They determine how people can use/develop their land and what they can reasonably expect to develop next door, down the street, or across town. They provide for overall consistency and compatibility between land uses and can be a determining factor in quality of life. The policies … also have a direct bearing on traffic, the feasibility of public transportation, and the quality of the air.*

City of Anderson General Plan

The planning boundaries of the *City of Anderson General Pla*n encompass areas within the city limits and the urban growth boundary. The City of Anderson released its updated general plan in May 2007 (City of Anderson 2007). The general plan is intended to guide land use planning within the city through the Year 2027. The following statement from the Land Use element of the general plan identifies some of the concerns surrounding land use decisions within the City of Anderson:

> *The Land Use Element describes the pattern of land development within the City of Anderson and the proposed expansion area and provides direction for the future development envisioned for the City. Also included in this Element are descriptions of geographic areas that are anticipated to be developed over the term of this General Plan and goals and policies to guide the City's decision makers in their review of development proposals. This Element also defines land use categories and provides supporting detail for the uses depicted upon the Anderson General Plan Land Use Diagram.*

Red Bluff General Plan

The planning boundaries for the *City of Red Bluff General Plan* encompass areas within the city limits and the urban growth boundary. The adopted

General Plan elements are as follows: Circulation element (1991), Housing element (2004), and Land Use, Natural Environment, Noise, and Safety elements (1993). The following statement from the Land Use element summarizes concerns relative to land use decisions in Red Bluff (City of Red Bluff 1993):

> *The land use element identifies the spatial arrangement of existing and proposed uses of land including public lands and facilities. It lays out the distribution of classes of land use, the intensity of those uses, and proposes a strategy of goals, objectives, policies and implementation measures to promote a wise use of land to promote the welfare of the community.*

17.3 Environmental Consequences and Mitigation Measures

17.3.1 Methods and Assumptions

To characterize existing land uses in the primary study area, pertinent planning documents were reviewed to identify objectives for the level, type, location, density, and intensity of development and to determine whether the alternatives would be in conflict with current plans and policies. Planning documents that were reviewed include the STNF LRMP (USFS 1995), the Management Guide for the NRA, the BLM RMPs and the general plans for the cities of Shasta Lake, Redding, Anderson, and Red Bluff and Shasta and Tehama counties. Land use maps and zoning maps were consulted to identify planned land uses. The analysis also included a review of aerial photography to determine existing land uses in the primary study area.

The impacts of each alternative are analyzed separately, starting with the analysis of the No-Action Alternative, followed by each of the action alternatives. The impact analysis includes a discussion of both direct and indirect impacts associated with each alternative.

17.3.2 Criteria for Determining Significance of Effects

An environmental document prepared to comply with NEPA must consider the context and intensity of the environmental effects that would be caused by, or result from, the proposed action. Under NEPA, the significance of an effect is used solely to determine whether an EIS must be prepared. An environmental document prepared to comply with CEQA must identify the potentially significant environmental effects of a proposed project. A "[s]ignificant effect on the environment" means a substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by the project" (State CEQA Guidelines, Section 15382). CEQA also requires that the environmental document propose feasible measures to avoid or substantially reduce significant environmental effects (State CEQA Guidelines, Section 15126.4(a)).

The following significance criteria were developed based on guidance provided by the State CEQA Guidelines and consider the context and intensity of the environmental effects as required under NEPA. Impacts of an alternative related to land use and planning would be significant if project implementation would do any of the following:

- Create land uses that are incompatible with existing and planned land uses adjacent to actions described as part of the project
- Introduce substantial nuisance effects on sensitive land uses that would disrupt use over an extended time period
- Conflict with any applicable land use plan, policy, ordinance, or regulation of an agency with jurisdiction over the project (including general plans, specific plans, and zoning ordinances) adopted for the purpose of avoiding or mitigating an environmental effect
- Disrupt or divide the physical arrangement of an established community
- Conflict with any applicable habitat conservation or natural community conservation plan

17.3.3 Topics Eliminated from Further Consideration

Effects of the proposed enlargement of Shasta Lake on the listed segments of the American River have been eliminated from further consideration in this EIS. The listed segment of the North Fork American River has been eliminated because it is above any regulated reaches and is many miles from the confluence of the American and Sacramento rivers. The lower American River has been eliminated because none of the alternatives would adversely affect its designation as a recreational river under the Federal WSRA or the PRC. Under each of the action alternatives, releases from Shasta Dam would increase from late spring through early autumn. Increased releases from Shasta Dam during this period would reduce the volume of water released from Folsom Dam during the primary recreation season on the lower American River (late spring through early autumn). Flow volumes and water levels within the lower American River would, however, remain substantially similar to existing conditions and would remain within the river's typical range of variation during the primary recreation season. During the secondary recreation season (autumn through spring), precipitation is greater, flows in the Sacramento River and Delta are higher, and releases from Shasta Dam would be reduced to increase storage in Shasta Lake. Reclamation may need to occasionally increase releases from Folsom Dam to accommodate demand and offset decreased releases from Shasta Dam. Flow volumes and water levels in the lower American River would, however, remain substantially similar to existing conditions and within the river's typical range of variation during the secondary recreation season.

The effects of the proposed enlargement on two IRAs, Backbone and Devils Rock, have been eliminated from further consideration in this EIS. Under the 18.5 foot increase, 0.3 percent of the Backbone IRA (39.2 acres) would be subject to inundation; Big Backbone Arm – 16.9 acres, Sacramento Arm – 22.3 acres. There would be no new road construction or timber harvest. There would be some vegetation removed in conjunction with the relocation of the Gooseneck Campground (boat-in), as well as removal of hazard trees at select locations identified by the STNF at coves known for high houseboat use. Under the 18.5 foot increase, 0.3 percent of the Devils Rock IRA would be subject to inundation; Pit Arm – 41.9 acres, Sacramento Arm – 22.3 acres. There would be no new road construction or timber harvest. There would be some vegetation removed in conjunction with removal of hazard trees at select locations identified by the STNF at high use houseboat coves. Collectively, approximately 20.6 miles of shoreline within the boundaries of these IRAs will be subject to effects similar to those described elsewhere in this EIS under the No-Action alternative, none of which are precluded in the 2001 Roadless Rule.

17.3.4 Direct and Indirect Effects

No-Action Alternative

Shasta Lake and Vicinity, Upper Sacramento River (Shasta Dam to Red Bluff), Lower Sacramento River and Delta, and CVP/SWP Service Areas
The impact discussion for the No-Action Alternative addresses all of both the primary and extended study areas together, because this alternative would not affect land use in either the primary or extended study area.

Impact LU-1 (No-Action): Disruption of Existing Land Uses No new facilities would be constructed and no existing facilities would be altered, expanded, or demolished. Therefore, no impact would occur. Mitigation is not required for the No-Action Alternative.

Impact LU-2 (No-Action): Conflict with Existing Land Use Goals and Policies of Affected Jurisdictions No new facilities would be constructed and no existing facilities would be altered, expanded, or demolished. Therefore, no impact would occur. Mitigation is not required for the No-Action Alternative.

CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

Shasta Lake and Vicinity and Upper Sacramento River (Shasta Dam to Red Bluff) The impact discussion for CP1 addresses the Shasta Lake and vicinity and upper Sacramento River portions of the primary study area together, because impacts from construction activities would affect both areas.

Impact LU-1 (CP1): Disruption of Existing Land Uses Project construction activities associated with enlarging Shasta Dam and relocating utilities, infrastructure, and public service and recreational facilities could result in short-term and long-term disruptions to land uses by interfering with the ability to use certain lands and interfering with access to certain lands. Construction activities that could disrupt land uses include the transport of project materials to and from project construction sites and the demolition and relocation of some utilities. This impact would be potentially significant.

It is anticipated that construction activities would be limited to the Shasta Lake and Vicinity portion of the primary study area; therefore, no impacts associated with disruption of existing land uses would be expected to occur downstream from Shasta Dam.

Construction activities specific to enlarging Shasta Dam would be limited to the existing footprint of the Shasta Dam facilities and areas immediately adjacent. The project construction site would be accessed by existing roadways (I-5, Shasta Dam Boulevard, and Lake Boulevard). The access roads allow commercial truck use and are capable of supporting project-generated traffic. Road modifications would be necessary to accommodate project traffic en route to the construction sites and access restrictions would occur. Noise, air quality, and traffic impacts along these local roadways are evaluated in separate sections of the EIS. Equipment staging areas would be sited to avoid affecting or conflicting with existing land uses.

Project construction activities associated with relocating utilities, infrastructure, and public service and recreational facilities could result in temporary and localized disruptions of existing land uses. Lake inundation resulting from future dam operations could result in long-term disruptions of land uses in the primary study area. The Utilities and Miscellaneous Minor Infrastructure Technical Memorandum provides descriptions and detailed maps of the utilities and infrastructure (e.g., roads, bridges, campgrounds, boat ramps) that would be demolished or relocated in the ancillary areas near Shasta Lake (Reclamation 2007). Chapter 18, “Recreation and Public Access,” evaluates the project’s impacts on recreational use, including short-term disruption of recreational use and/or change in the type and location of recreational use. Chapter 21, “Utilities and Service Systems,” of this EIS evaluates the project’s impacts on utilities and service systems, and the environmental impacts of utilities demolition and relocation are evaluated in the pertinent technical chapters of the EIS (e.g., Water Quality, Air Quality and Climate, and Noise and Vibration).

Construction activities would affect major features around Shasta Lake and vicinity and would require demolition, relocation, modification, or reconstruction to prevent inundation of the features caused by an increased reservoir elevation. The major features affected would include:

- Major roads and road segments (Lakeshore Drive realignment)
- Vehicle bridges (Charlie Creek, Doney Creek, McCloud River, Didallas Creek, and Second Creek)

- Railroad bridge
- Utilities and service systems infrastructure
- Campgrounds and picnic areas
- Boat ramps and associated parking areas
- Buildings (resort/marina, residential, USFS facilities)

The communities of Lakeshore and Sugarloaf would be affected the most by transportation infrastructure relocation activities. Seventy-five small road segments (both paved and unpaved) would need to be modified. CP1 would result in the inundation of Lakeshore Drive at numerous locations south of Charlie Creek Bridge and in two locations between the Charlie Creek and Doney Creek bridges. Relocation of Lakeshore Drive and the UPRR would occur near existing residences and businesses. Road construction activity could result in temporary and localized increases in dust, noise, and construction truck traffic and potential disruption of access.

Seven bridges would need to be replaced. Construction activities associated with bridge modifications and relocations, particularly in areas with existing development such as Bridge Bay Marina and the communities of Lakeshore and Sugarloaf, could result in short-term disruptions of nearby residential, commercial, and industrial land uses. Bridge construction activity could result in temporary and localized increases in dust, noise, and construction truck traffic and potential disruption of access.

Approximately 67,000 feet of power and telecommunications lines would need to be demolished and reconstructed at a number of locations, including powerlines that cross Shasta Lake. Utilities infrastructure relocation activities could result in short-term disruptions of land uses in communities and recreation areas around Shasta Lake. Relocation activities could require partial or full road closures and other access restrictions to ensure public safety. Utilities relocation activities could also result in temporary and localized increases in dust, noise, heavy equipment traffic, and other project traffic.

An estimated 50 buildings would be affected under a 6.5-foot dam raise. The buildings have been categorized as residential (cottages, homes, etc.), commercial (resorts, marinas, stores, etc.), and USFS sites (work stations, campground buildings, recreation site restrooms, etc.). Buildings within the inundation area would be removed, and some would be relocated. Utilities associated with the removed buildings (water systems, septic systems, telecommunications and power facilities) would also require demolition or abandonment. Construction activity related to removal and/or relocation of buildings would result in temporary and localized increases in dust, noise, and construction truck traffic and potential disruption of access. Some existing marinas would need to be modified or relocated, which would disrupt existing commercial and recreational land uses. See the Engineering Summary Appendix for additional details.

Reservoir dikes would be required in the areas of Antlers/Lakeshore and railroad embankments would be required at the UPRR track at the south end of Bridge Bay for protection of existing infrastructure from increased full pool elevations. Additional sites for dike and embankment construction could be added in the future. Dike and embankment construction could serve to lessen long-term land use impacts resulting from the project by eliminating the need to remove and relocate a number of structures. Construction activities associated with dike and embankment construction would result in temporary and localized increases in dust, noise, and construction truck traffic and potential disruption of access.

Project implementation could result in short-term disruptions of land uses of parcels around Shasta Lake and vicinity during construction and relocation activities; long-term disruptions of land use could also result from project operations. This impact would be potentially significant. Mitigation for this impact is proposed in Section 17.3.5, “Mitigation Measures.”

Impact LU-2 (CP1): Conflict with Existing Land Use Goals and Policies of Affected Jurisdictions Project implementation would result in inundating land around Shasta Lake, which could conflict with land use goals and policies of affected jurisdictions. Relocation of utilities and service systems resulting from project implementation could also conflict with existing land use goals and policies. This impact would be potentially significant.

It is anticipated that construction activities would be limited to the Shasta Lake and vicinity portion of the primary study area; therefore, no conflicts with existing land use goals and policies would be expected to occur in planning jurisdictions downstream from Shasta Dam.

Project implementation would result in an increase in reservoir pool elevation during extreme storm events, which could result in the flooding of approximately 1,110 acres in the lower elevations around Shasta Lake. To prevent utilities and infrastructure damage, Reclamation would relocate roads, utilities and service systems, marinas, and other structures and would modify a number of bridges. Relocation plans are based on broad assumptions regarding optimum construction, operation, and environmental conditions. Areas planned for relocation activities could have land use designations that conflict with the land use proposed by the project. It is anticipated that some relocation activities would conflict with land use designations. Although refinements have been made to a number of relocation sites subsequent to the DEIS, additional engineering information will be required for some sites before a detailed analysis can be made. Once relocation sites are finalized, the proposed land use would be compared to the existing land uses and land use designations to determine consistency with the STNF LRMP, BLM RMP, the Shasta County General Plan, and the Shasta County Zoning Ordinance as applicable.

Areas that would be most affected by project implementation are located on the Sacramento Arm of Shasta Lake and include the communities of Sugarloaf and Lakeshore. A number of existing residential land uses would be inundated by a higher full pool elevation in Shasta Lake.

Most recreation facilities that could be inundated by project implementation would be relocated; some recreation facilities would be relocated adjacent to existing recreation facilities. Sites proposed for the relocation of recreational facilities could be inconsistent with the current land use designations. Reclamation would cooperate with USFS and/or BLM to find the most suitable relocation sites that would be consistent with the STNF LRMP, the NRA Management Guide, and the BLM RMP.

The proposed use of Turntable Bay as a developed recreation area would require an amendment to the USFS STNF LRMP (USFS 1995) to change the land management prescription from Roaded Recreation (Prescription III) to Roaded, High Density Recreation (Prescription IV). Under the USFS Planning Regulations, this would be considered a nonsignificant amendment to the STNF LRMP.

Open space lands would be inundated. STNF LRMP land allocations that would be inundated include Riparian Reserve allocations. Loss of the use of NRA lands would be inconsistent with STNF LRMP and NRA goals and policies. Reclamation would coordinate mitigation measures with USFS to minimize the impacts from losing the ability to use lands around Shasta Lake.

The STNF LRMP identified several segments of the Sacramento River upstream from the NRA boundary as eligible for consideration under the Federal WSRA. One of these segments extends from the NRA boundary upstream to Box Canyon Dam. Only 6.7 miles of this 37 mile segment is on NFS lands managed by the STNF; none of these lands are within the segment affected by CP1. Under CP1, approximately 1,100 feet of this segment would be inundated.

Vegetation clearing required for the relocation of structures, marinas, recreation facilities, and utilities could be inconsistent with the STNF LRMP, BLM RMP, the *Shasta County General Plan*, and the Shasta County Zoning Ordinance. Many relocation activities would require vegetation clearing before construction. Specific clearing sites would be dependent on the sites chosen for utilities, building, and infrastructure relocation. The sites have not been determined at this time. Once specific relocation sites are known and the areas requiring vegetation clearance are determined, an analysis would be performed to determine whether the proposed action would be inconsistent with the STNF LRMP, the NRA Management Guide, the *Shasta County General Plan*, and the

Shasta County Zoning Ordinance. Reclamation would obtain authorization and/or use permits, or other suitable instruments, from USFS for actions within the jurisdiction of USFS; Reclamation would also obtain authorization and/or use permits from Shasta County and the California Department of Forestry and Fire Protection for vegetation clearing activities within the jurisdiction of Shasta County.

The overall project actions, as authorized by Congress, may not be consistent with the STNF LRMP (USFS 1995) as amended. Project-specific STNF LRMP amendment(s) may be required for standards and guidelines pertaining to the following LRMP elements: caves, visual quality, late successional reserves, riparian reserves, survey and manage species, and special-status species (e.g., Shasta snow-wreath). Scoping efforts to date indicate that amendments to the STNF LRMP are likely to be nonsignificant. The USFS decision would include a project-specific exception to these standards.

The STNF LRMP includes several resource-specific goals and objectives that enable the USFS to balance resource conflicts that could occur as a result of project authorization. One example is the goal to "provide for continued use and new development of hydroelectric facilities." The USFS understands that Congressional authorization may result in amendments or exemptions to land allocations and/or specific LRMP standards and guidelines in a manner that would enable an authorized project to be consistent with the STNF LRMP. If required, Reclamation would cooperate with USFS in support of any efforts to amend the STNF LRMP; this could require additional effort to fully comply with the National Forest Management Act and NEPA.

Site-specific information is needed for all infrastructure, building, and utilities relocation plans to review completely for consistency with existing land use planning documents, primarily the STNF LRMP and the *Shasta County General Plan*. Given the magnitude of facilities that might be relocated, including existing marinas and utilities, it is anticipated that there would be some inconsistencies with existing planning policies. This impact would be potentially significant. Mitigation for this impact is proposed in Section 17.3.5, "Mitigation Measures."

Lower Sacramento River and Delta and CVP/SWP Service Areas

Impact LU-3 (CP1): Disruption of Existing Land Uses Construction activities would be limited to the primary study area; therefore, there would be no disruption of existing land uses in the extended study area. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact LU-4 (CP1): Conflict with Existing Land Use Goals and Policies of Affected Jurisdictions Construction activities would be limited to the primary study area; therefore, no conflicts with existing land use goals and policies would occur in the extended study area. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

Shasta Lake and Vicinity and Upper Sacramento River (Shasta Dam to Red Bluff) The impact discussion for CP2 addresses the Shasta Lake and vicinity and upper Sacramento River portions of the primary study area together, because impacts from construction activities would affect both areas.

Impact LU-1 (CP2): Disruption of Existing Land Uses Project construction activities associated with enlarging Shasta Dam and relocating utilities, infrastructure, and public service and recreational facilities could result in short-term and long-term disruptions to land uses by interfering with the ability to use certain lands and interfering with access to certain lands. Construction activities that could disrupt land uses include the transport of project materials to and from project construction sites. Limitations on site use associated with construction at a particular site or facility would also occur. This impact would be potentially significant.

This impact would be similar to Impact LU-1 (CP1). A dam raise of 12.5 feet would result in a larger area of inundation than under CP1, which would, in turn, result in additional relocation of existing structures, infrastructure, and utilities and a longer duration for the impact. Reclamation estimates the construction of CP2 would take 5 years, which would be 6 months longer than for CP1. CP2 would, therefore, result in longer-term disruptions of land use than would CP1. Approximately 500 additional acres would be inundated by CP2, totaling 1,750 acres of land that would be inundated by Shasta Dam operations. Specific information regarding the location and number of structures that would be permanently lost will be incorporated into the land use impact analysis.

Project implementation could result in short-term and long-term disruptions of existing land uses. Therefore, this impact would be potentially significant. Mitigation for this impact is proposed in Section 17.3.5, “Mitigation Measures.”

Impact LU-2 (CP2): Conflict with Existing Land Use Goals and Policies of Affected Jurisdictions Project implementation could result in a permanent loss of inundated land around Shasta Lake, which could conflict with land use goals and policies of affected jurisdictions. Relocation of utilities and service systems resulting from project implementation could also conflict with existing land use goals and policies. This impact would be potentially significant.

This impact would be similar to Impact LU-2 (CP1). A dam raise of 12.5 feet would create a larger area of inundation than under CP1, which, compared to CP1, would result in additional relocation of structures and infrastructure that would be subject to USFS and Shasta County land use goals and policies.

Under CP2, approximately 1,800 feet of the eligible segment of the Sacramento River would be inundated. The portion of this segment subject to inundation is on private lands, not subject to the STNF LRMP.

A site-specific analysis would be conducted to determine where relocation activities and permanent land base losses resulting from project implementation would be inconsistent with the STNF LRMP, the NRA Management Guide, the *Shasta County General Plan*, and the Shasta County Zoning Ordinance.

Project implementation could result in short-term and long-term impacts that could conflict with existing land use goals and policies. Therefore, this impact would be potentially significant. Mitigation for this impact is proposed in Section 17.3.5, "Mitigation Measures."

Lower Sacramento River and Delta and CVP/SWP Service Areas
Impact LU-3 (CP2): Disruption of Existing Land Uses Construction activities would be limited to the primary study area; therefore, there would be no disruption of existing land uses in the extended study area. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact LU-4 (CP2): Conflict with Existing Land Use Goals and Policies of Affected Jurisdictions Construction activities would be limited to the primary study area; therefore, no conflicts with existing land use goals and policies would occur in the extended study area. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

CP3 – 18.5-Foot Dam Raise, Agricultural Water Supply Reliability and Anadromous Fish Survival

Shasta Lake and Vicinity and Upper Sacramento River (Shasta Dam to Red Bluff) The impact discussion for CP3 addresses the Shasta Lake and vicinity and upper Sacramento River portions of the primary study area together, because impacts from construction activities would affect both areas.

Impact LU-1 (CP3): Disruption of Existing Land Uses Project construction activities associated with enlarging Shasta Dam and relocating utilities, infrastructure, and public service and recreational facilities could result in short-term and long-term disruptions to land uses by interfering with the ability to use certain lands and interfering with access to certain lands. Construction activities that could disrupt land uses include the transport of project materials to and from project construction sites. Limitations on site use associated with construction at a particular site or facility would also occur. This impact would be potentially significant.

This impact would be similar to Impact LU-1 (CP1). A dam raise of 18.5 feet would result in a larger area of inundation than under CP1, which would result in additional relocation of existing structures and infrastructure compared to CP1 and a longer duration for the impact. Reclamation estimates that construction of CP3 would take 60 months, which would be 6 months longer than for CP1. Approximately 2,500 acres of land would be inundated by CP3 and, according to the 2003 infrastructure inventory at Shasta Lake, an estimated 130 buildings would be inundated under an 18.5-foot dam raise (Shasta County 2003). Specific information regarding the location and number of structures that would be permanently lost would be incorporated into the land use impact analysis. CP3 would require a more extensive (longer and wider) system of reservoir dikes than CP1 to accommodate increased Shasta Lake elevations resulting from Shasta Dam operations. A dam raise of 18.5 feet would result in the encroachment of 31 road segments. Lakeshore Drive could be inundated for nearly its entire length between Charlie Creek and Doney Creek.

Project implementation could result in short- and long-term disruptions of existing land uses. Therefore, this impact would be potentially significant. Mitigation for this impact is proposed in Section 17.3.5, “Mitigation Measures.”

Impact LU-2 (CP3): Conflict with Existing Land Use Goals and Policies of Affected Jurisdictions Project implementation could result in a permanent loss of inundated land around Shasta Lake, which could conflict with land use goals and policies of affected jurisdictions. Relocation of utilities and service systems resulting from project implementation could also conflict with existing land use goals and policies. This impact would be potentially significant.

This impact would be similar to Impact LU-2 (CP1). A dam raise of 18.5 feet would result in a larger area of inundation than CP1, which, compared to CP1, would result in additional relocation of existing structures and infrastructure that would be subject to existing USFS and Shasta County land use goals and policies.

Under CP3, approximately 2,200 feet of the eligible segment of the Sacramento River would be inundated. The portion of this segment subject to inundation is on private lands, not subject to the STNF LRMP.

A site-specific analysis would be conducted to determine where relocation activities and permanent land base losses resulting from project implementation would be inconsistent with the STNF LRMP, the NRA Management Guide, the *Shasta County General Plan,* and the Shasta County Zoning Ordinance.

Project implementation could result in short-term and long-term impacts that could conflict with existing land use goals and policies. Therefore, this impact would be potentially significant. Mitigation for this impact is proposed in Section 17.3.5, “Mitigation Measures.”

Lower Sacramento River and Delta and CVP/SWP Service Areas

Impact LU-3 (CP3): Disruption of Existing Land Uses Construction activities would be limited to the primary study area; therefore, there would be no disruption of existing land uses in the extended study area. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact LU-4 (CP3): Conflict with Existing Land Use Goals and Policies of Affected Jurisdictions Construction activities would be limited to the primary study area; therefore, no conflicts with existing land use goals and policies would occur in the extended study area. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

CP4 and CP4A – 18.5-Foot Dam Raise, Anadromous Fish Focus with Water Supply Reliability

Shasta Lake and Vicinity and Upper Sacramento River (Shasta Dam to Red Bluff) The impact discussion for CP4 and CP4A addresses the Shasta Lake and vicinity and upper Sacramento River portions of the primary study area together, because impacts from construction activities would affect both areas.

Impact LU-1 (CP4 and CP4A): Disruption of Existing Land Uses Project construction activities associated with enlarging Shasta Dam and relocating utilities, infrastructure, and public service and recreational facilities could result in short-term and long-term disruptions to land uses by interfering with the ability to use certain lands and interfering with access to certain lands. Gravel augmentation and the habitat restoration activities along the upper Sacramento River could also cause minor disruptions of existing land uses in the primary study area. Construction activities that could disrupt land uses include the transport of project materials and equipment to and from project construction sites. Limitations on site use associated with construction at a particular site or facility would also occur. This impact would be potentially significant for CP4 and CP4A.

This impact would be similar to Impact LU-1 (CP1). Therefore, this impact would be potentially significant for CP4. Mitigation for this impact is proposed in Section 17.3.5, “Mitigation Measures.”

This impact would be similar to Impact LU-1 (CP1). Therefore, this impact would be potentially significant for CP4A. Mitigation for this impact is proposed in Section 17.3.5, “Mitigation Measures.”

Impact LU-2 (CP4 and CP4A): Conflict with Existing Land Use Goals and Policies of Affected Jurisdictions Project implementation could result in a permanent loss of inundated land around Shasta Lake, which could conflict with land use goals and policies of affected jurisdictions. Relocation of utilities and service systems resulting from project implementation could also conflict with existing land use goals and policies, resulting in a significant impact. The proposed gravel augmentation and the habitat restoration activities along the upper Sacramento River for CP4 and CP4A would not alter land uses and would not be expected to conflict with existing land use goals and policies. This impact would be potentially significant for CP4 or CP4A.

This impact would be similar to Impact LU-2 (CP3). Therefore, this impact would be potentially significant for CP4. Mitigation for this impact is proposed in Section 17.3.5, “Mitigation Measures.”

This impact would be similar to Impact LU-2 (CP3). Therefore, this impact would be potentially significant for CP4A. Mitigation for this impact is proposed in Section 17.3.5, “Mitigation Measures.”

Lower Sacramento River and Delta and CVP/SWP Service Areas
Impact LU-3 (CP4 and CP4A): Disruption of Existing Land Uses Construction activities would be limited to the primary study area; therefore, there would be no disruption of existing land uses in the extended study area. No impact would occur for CP4 or CP4A. Mitigation for this impact is not needed, and thus not proposed.

Impact LU-4 (CP4 and CP4A): Conflict with Existing Land Use Goals and Policies of Affected Jurisdictions Construction activities would be limited to the primary study area; therefore, no conflicts with existing land use goals and policies would occur in the extended study area. No impact would occur for CP4 or CP4A. Mitigation for this impact is not needed, and thus not proposed.

CP5 – 18.5-Foot Dam Raise, Combination Plan
Shasta Lake and Vicinity and Upper Sacramento River (Shasta Dam to Red Bluff) The impact discussion for CP5 addresses the Shasta Lake and vicinity and upper Sacramento River portions of the primary study area together, because impacts from construction activities would affect both areas.

Impact LU-1 (CP5): Disruption of Existing Land Uses Project construction activities associated with enlarging Shasta Dam and relocating utilities, infrastructure, and public service and recreational facilities could result in short-term and long-term disruptions to land uses by interfering with the ability to use certain lands and interfering with access to certain lands. Gravel augmentation and the habitat restoration activities along the upper Sacramento River could also cause minor disruptions of existing land uses in the primary study area. Construction activities that could disrupt land uses include the transport of project materials and equipment to and from project construction sites. Limitations on site use associated with construction at a particular site or facility would also occur. This impact would be potentially significant.

This impact would be similar to Impact LU-1 (CP1). Therefore, this impact would be potentially significant. Mitigation for this impact is proposed in Section 17.3.5, “Mitigation Measures.”

Impact LU-2 (CP5): Conflict with Existing Land Use Goals and Policies of Affected Jurisdictions Project implementation could result in a permanent loss of inundated land around Shasta Lake, which could conflict with land use goals and policies of affected jurisdictions. Relocation of utilities and service systems resulting from project implementation could also conflict with existing land use goals and policies, resulting in a significant impact. Gravel augmentation and the habitat restoration activities along the upper Sacramento River would not alter land uses and would not be expected to conflict with existing land use goals and policies. This impact would be potentially significant.

This impact would be similar to Impact LU-2 (CP-3). Therefore, this impact would be potentially significant. Mitigation for this impact is proposed in Section 17.3.5, "Mitigation Measures."

Lower Sacramento River and Delta and CVP/SWP Service Areas
Impact LU-3 (CP5): Disruption of Existing Land Uses Construction activities would be limited to the primary study area; therefore, there would be no disruption of existing land uses in the extended study area. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

Impact LU-4 (CP5): Conflict with Existing Land Use Goals and Policies of Affected Jurisdictions Construction activities would be limited to the primary study area; therefore, no conflicts with existing land use goals and policies would occur in the extended study area. No impact would occur. Mitigation for this impact is not needed, and thus not proposed.

17.3.5 Mitigation Measures

Table 17-2 presents a summary of mitigation measures for land use.

Table 17-2. Summary of Mitigation Measures for Land Use

Impact		No-Action Alternative	CP1	CP2	CP3	CP4/ CP4A	CP5
Impact LU-1: Disruption of Existing Land Uses (Shasta Lake and Vicinity and Upper Sacramento River)	LOS before Mitigation	NI	PS	PS	PS	PS	PS
	Mitigation Measure	None required.	LU-1: Minimize and/or Avoid Temporary Disruptions to Local Communities.				
	LOS after Mitigation	NI	SU	SU	SU	SU	SU
Impact LU-2: Conflict with Existing Land Use Goals and Policies of Affected Jurisdictions (Shasta Lake and Vicinity and Upper Sacramento River)	LOS before Mitigation	NI	PS	PS	PS	PS	PS
	Mitigation Measure	None required.	LU-2: Minimize and/or Avoid Conflicts with Land Use Goals and Policies.				
	LOS after Mitigation	NI	SU	SU	SU	SU	SU
Impact LU-3: Disruption of Existing Land Uses (Lower Sacramento River, Delta, CVP/SWP Service Areas)	LOS before Mitigation	NI	NI	NI	NI	NI	NI
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	NI	NI	NI	NI	NI	NI
Impact LU-4: Conflict with Existing Land Use Goals and Policies of Affected Jurisdictions (Lower Sacramento River, Delta, CVP/SWP Service Areas)	LOS before Mitigation	NI	NI	NI	NI	NI	NI
	Mitigation Measure	None required.	None needed; thus, none proposed.				
	LOS after Mitigation	NI	NI	NI	NI	NI	NI

Key:
CP = Comprehensive Plan
CVP = Central Valley Project
LOS = level of significance
LTS = less than significant
NI = no impact
PS = potentially significant
SU = significant and unavoidable
SWP = State Water Project

No-Action Alternative

No mitigation measures are required for this alternative.

CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

No mitigation is required for Impacts LU-3 (CP1) and LU-4 (CP1). Mitigation is provided below for the impacts of CP1 on land uses in the primary study area.

Mitigation Measure LU-1 (CP1): Minimize and/or Avoid Temporary Disruptions to Local Communities To minimize and/or avoid temporary disruption to local communities, the following measures will be implemented during project construction:

- Before construction, Reclamation and its contractor will develop a construction plan for each affected community (i.e., Lakeshore, Sugarloaf), consisting of the following:

  - Alternate access routes will be identified for local residences and businesses affected by project construction activities.

  - Construction and staging areas will be fenced, secured, and clearly marked. Security will be provided to ensure public safety.

  - Public parking areas outside of the construction staging areas will be kept clear of construction-related equipment of materials at all times.

  - Any open trenches will be covered or secured after daily activities to protect worker and public safety.

  - Construction activities near noise-sensitive land uses (e.g., near residences, campgrounds) or land uses that experience high levels of public activity (e.g., boat ramps, marinas) will be restricted to days and hours that minimize land use conflicts to the extent feasible.

- The contractor will provide advance notice of the construction activities schedule to the affected community members (e.g., residences, property owners, business owners, and public facilities operators), including posting of signs in the project area.

- The contractor will provide a phone number and community contact for inquiries about the project throughout the construction period.

- Reclamation and its contractor will coordinate with local jurisdictions and obtain all necessary permits (e.g., encroachment permit, utility excavation permit), will comply with permit conditions established to minimize construction impacts, and will assign an inspector to the project to oversee construction activities.

Implementation of this mitigation measure would substantially reduce land use capability impacts generated by short-term construction activities, but might not reduce all impacts to a less-than-significant level. As a result, Impact LU-1 (CP1) would be significant and unavoidable.

Mitigation Measure LU-2 (CP1): Minimize and/or Avoid Conflicts with Land Use Goals and Policies To reduce conflicts with land use goals and policies of affected jurisdictions, Reclamation will implement the following measures:

- Reclamation will coordinate with USFS to find the most suitable relocation sites for recreation facilities with respect to consistency with the STNF LRMP and the NRA Management Guide.

- Reclamation will coordinate with USFS to identify measures to minimize the impacts of the loss of use of USFS lands around Shasta Lake (including open space and Riparian Reserve allocations) caused by inundation, and measures to offset inconsistencies with the STNF LRMP and NRA goals and policies related to the loss of use of NRA lands.

- As utility and facility relocation sites are being refined, Reclamation will evaluate consistency of the relocated land uses with the STNF LRMP, the NRA Management Guide, the *Shasta County General Plan*, and the county zoning ordinance. To the degree possible, Reclamation will design the relocated utilities and facilities to comply with these plans and ordinances. If needed, Reclamation will seek permits, easements, and/or plan amendments.

Implementation of this mitigation measure would substantially reduce land use plan consistency impacts, but might not reduce all impacts to a less-than-significant level. As a result, Impact LU-2 (CP1) would be significant and unavoidable.

CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

No mitigation is required for Impacts LU-3 (CP2) and LU-4 (CP2). Mitigation is provided below for the impacts of CP2 on land uses in the primary study area.

Mitigation Measure LU-1 (CP2): Minimize and/or Avoid Temporary Disruptions to Local Communities This mitigation measure is identical to Mitigation Measure LU-1 (CP1). Implementation of this mitigation measure would substantially reduce land use capability impacts generated by short-term construction activities, but might not reduce all impacts to a less-than-significant level. As a result, Impact LU-1 (CP2) would be significant and unavoidable.

Mitigation Measure LU-2 (CP2): Minimize and/or Avoid Conflicts with Land Use Goals and Policies This mitigation measure is identical to Mitigation Measure LU-2 (CP1). Implementation of this mitigation measure would substantially reduce land use plan consistency impacts, but might not reduce all impacts to a less-than-significant level. As a result, Impact LU-2 (CP2) would be significant and unavoidable.

CP3 – 18.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply

No mitigation is required for Impacts LU-3 (CP3) and LU-4 (CP3). Mitigation is provided below for the impacts of CP3 on land uses in the primary study area.

Mitigation Measure LU-1 (CP3): Minimize and/or Avoid Temporary Disruptions to Local Communities This mitigation measure is identical to Mitigation Measure LU-1 (CP1). Implementation of this mitigation measure would substantially reduce land use capability impacts generated by short-term construction activities, but might not reduce all impacts to a less-than-significant level. As a result, Impact LU-1 (CP3) would be significant and unavoidable.

Mitigation Measure LU-2 (CP3): Minimize and/or Avoid Conflicts with Land Use Goals and Policies This mitigation measure is identical to Mitigation Measure LU-2 (CP1). Implementation of this mitigation measure would substantially reduce land use plan consistency impacts, but might not reduce all impacts to a less-than-significant level. As a result, Impact LU-2 (CP3) would be significant and unavoidable.

CP4 and CP4A – 18.5-Foot Dam Raise, Anadromous Fish Focus with Water Supply Reliability

No mitigation is required for Impacts LU-3 (CP4 and CP4A) and LU-4 (CP4 and CP4A) in the extended study area. Mitigation is provided below for the impacts of CP4 or CP4A on land uses in the primary study area.

Mitigation Measure LU-1 (CP4 and CP4A): Minimize and/or Avoid Temporary Disruptions to Local Communities This mitigation measure is identical to Mitigation Measure LU-1 (CP1). Implementation of this mitigation measure would substantially reduce land use capability impacts generated by short-term construction activities, but might not reduce all impacts to a less-than-significant level. As a result, Impact LU-1 (CP4 and CP4A) would be significant and unavoidable.

Mitigation Measure LU-2 (CP4 and CP4A): Minimize and/or Avoid Conflicts with Land Use Goals and Policies This mitigation measure is identical to Mitigation Measure LU-2 (CP1). Implementation of this mitigation measure would substantially reduce land use plan consistency impacts, but might not reduce all impacts to a less-than-significant level. As a result, Impact LU-2 (CP4 and CP4A) would be significant and unavoidable.

CP5 – 18.5-Foot Dam Raise, Combination Plan

No mitigation is required for Impacts LU-3 (CP5) and LU-4 (CP5) for the extended study area. Mitigation is provided below for the impacts of CP5 on land uses in the primary study area.

Mitigation Measure LU-1 (CP5): Minimize and/or Avoid Temporary Disruptions to Local Communities This mitigation measure is identical to Mitigation Measure LU-1 (CP1). Implementation of this mitigation measure would substantially reduce land use capability impacts generated by short-term construction activities, but might not reduce all impacts to a less-than-significant level. As a result, Impact LU-1 (CP5) would be significant and unavoidable.

Mitigation Measure LU-2 (CP5): Minimize and/or Avoid Conflicts with Land Use Goals and Policies This mitigation measure is identical to Mitigation Measure LU-2 (CP1). Implementation of this mitigation measure would substantially reduce land use plan consistency impacts, but might not reduce all impacts to a less-than-significant level. As a result, Impact LU-2 (CP5) would be significant and unavoidable.

17.3.6 Cumulative Effects

Chapter 3, "Considerations for Describing the Affected Environment and Environmental Consequences," discusses overall cumulative impacts methodology related to the action alternatives, including the relationship to the CALFED Bay-Delta Program Programmatic EIS/EIR cumulative impacts analysis, qualitative and quantitative assessment, past and future actions in the study area, and significance criteria. Table 3-1, "Present and Reasonably Foreseeable Future Actions Included in the Analysis of Cumulative Impacts, by Resource Area," lists the present and reasonably foreseeable future projects considered quantitatively and qualitatively within the cumulative impacts analysis. This cumulative impacts analysis accounts for potential project impacts combined with the impacts of existing facilities, conditions, land uses, and reasonably foreseeable actions expected to occur in the study area on a qualitative and quantitative level. None of the programs or projects listed in Table 3-1 under Quantitative Analysis would affect land use or planning in the primary study area. In addition, none of the SLWRI alternatives would affect land uses and planning in the extended study area; therefore, there would be no cumulative impacts in the extended study area. The following analysis is based on the reasonably foreseeable programs and projects listed in the Qualitative Analysis section of Table 3-1.

Current land uses have been impacted in the past by water development projects, land use development, transportation improvements, recreation development, and other construction projects that are inconsistent with land use planning documents.

The action alternatives could temporarily affect land use in the Shasta Lake and vicinity portion of the primary study area during construction, and some components might be inconsistent with the STNF LRMP, the NRA Management Guide, the *Shasta County General Plan*, and the county zoning ordinance. In addition to the projects identified by the City of Shasta Lake (Moody Flats EIR and Mountain Gate at Shasta Mixed-Use Area Plan EIR) in their comments on the DEIS, there are two present or reasonably foreseeable future actions, the Antlers Bridge replacement and the Iron Mountain Restoration Plan, located in the immediate vicinity of Shasta Lake. With respect to projects currently undergoing CEQA review, these projects are still in the planning phase and there is uncertainty as to what, if any, action alternatives may be selected; therefore, they are not considered as reasonably foreseeable. The Antlers Bridge and Iron Mountain project do have the potential to damage or disrupt utilities and public service systems infrastructure. The Antlers Bridge replacement is currently under construction and is expected to be completed in 2015, which is before any of the action alternatives would begin. With respect to the Iron Mountain Mine Restoration Plan, it is unlikely that this activity would occur simultaneously with the action alternatives, or would considerably and adversely affect use of the same land. Therefore, construction or mitigation activities related to implementation of the proposed SLWRI alternatives would not contribute considerably to significant cumulative impacts related to temporary land use impacts. The cumulative effects of the action alternatives and the two present or reasonably foreseeable future actions on resources managed consistent with the STNF LRMP, the NRA Management Guide, the *Shasta County General Plan*, and the county zoning ordinance are addressed in the other pertinent technical chapters of the EIS.